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JOURNAL OF PALEONTOLOGY

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UPPER KINKAID (MISSISSIPPIAN) MICROFAUNA FROM JOHNSON COUNTY, ILLINOIS

CHALMER L. COOPER
U. S. Geological Survey

ABSTRACT—In northwestern Johnson County, Illinois, the Wayside formation (Lower Pennsylvanian) rests with apparently slight disconformity upon the Kinkaid formation (upper Chester). An important and varied microfauna, consisting of Foraminifera, ostracodes, and conodonts is described and compared with Morrow microfaunas from the Midcontinent and other areas. The Foraminifera include the genera *Endothyra*, *Glomospira*, *Hyperammina*, *Palaeotextularia*, *Trepeilopsis*, and *Millerella*. The last is specifically described from the Mississippian for the first time. Five genera of conodonts and 20 genera (35 species) of ostracodes are included in the fauna.

THIS paper presents the microfauna from beds that are thought to be the youngest Chester in the area regarded as the type for the Mississippian system, where these beds could be examined and studied in relation to the superjacent Pennsylvanian. The type area for the Kinkaid formation is located along Kinkaid Creek, which cuts through the formation in NW. ¼ sec. 6, T. 8 S., R. 4 W., Jackson County, Illinois. This is less than 15 miles southeast of the town of Chester and the locality from which the fauna in question was collected is about 40 miles southeast of Chester. All known outcrops of the Kinkaid in southern Illinois that might show the contact with the overlying Pennsylvanian were visited in order to obtain as much data as possible on the contact relations of the Pennsylvanian-Mississippian boundary. The best section observed is that exposed on a north tributary of Lick Creek, which flows southeast across sec. 31, T. 11 S., R. 2 E., crossing the upper Kinkaid boundary in the northwest quarter of the section. This outcrop was described in detail by Lamar (1925, p. 80) who measured about 30 feet of Pottsville (Wayside) overlying 91 feet of the Kinkaid formation, the latter containing about one-third shale and two-thirds limestone. The details of the contact relations, modified somewhat from Lamar's subdivisions, are shown in figure 1.

A coral fauna from these beds was described by Easton (1945) who correlates the Kinkaid beds containing *Kinkadia trigonalis*, *Triplophyllites palmatus*, and *Caninostrotion variabilis* with the upper part of the Pitkin formation of western Arkansas. These corals were obtained from the massive limestone at the base of the section (fig. 1) and the thin limestones a short distance above it. (between samples 2 and 5). Concerning the coral fauna he concluded (p. 384):

. . . the geographic distribution of the corals

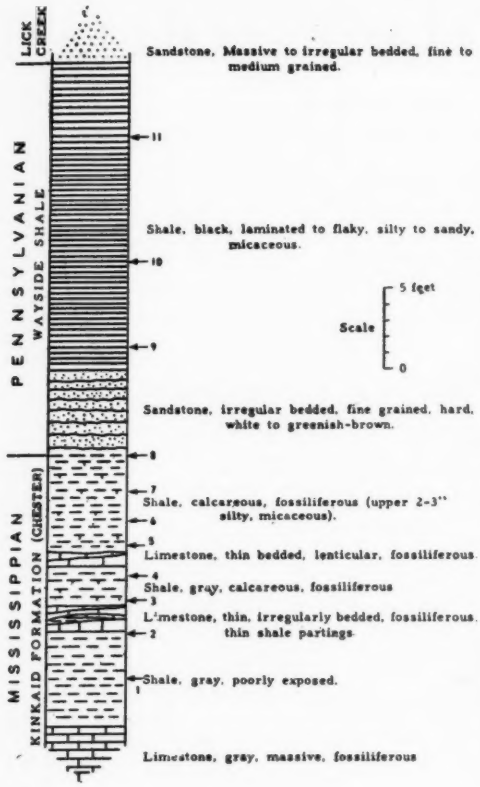


FIG. 1—Mississippian-Pennsylvanian contact in Johnson County, Illinois. The arrows to the right of the column show the approximate position of samples collected for study. The beds were sampled so that all zones from the top of the massive limestone at the bottom of the column to the base of the Lick Creek sandstone were collected.

shows that the two basins (Arkansas and Illinois) were connected and that favorable ecologic conditions of unknown duration enabled faunal migration of some distinctive organisms.

All zones in the Kinkaid shales above the massive limestone shown at the base of the column in figure 1 contain a microfauna in varying amounts, principally ostracodes. However, the samples above and below the upper thin irregularly bedded limestone proved to be the most fruitful, zone 5 furnishing the fusulines which are described later. The Waysides shales above the Kinkaid are barren of fossils.

A short time ago the very primitive, short axis fusuline, *Millerella*, was described by Thompson (1942, p. 404). The holotype came from the type locality of the Marble Falls formation in Burnet County, Texas, and the paratypes were collected from the "Bend" series in the Hueco Mountains of

EXPLANATION OF PLATE 19

FIGS. *1–5*—*Millerella chesterensis* Cooper, n. sp. *1*, *4*, Saggital sections with endothyroid juvenarial and irregular coiling as shown by the elongate volution and lack of continuity of the tunne, in the plane of the section, ×100. *2*, *3*, Axial sections, showing modified hour-glass outline, ×100. *5*, Enlargement of *1* to show details of coiling of first volution in a plane at right angles to the plane of the section, ×200. Kinkaid formation, bed 5, Johnson County, Illinois. (p. 85)

6–8—*Millerella zelleri* Cooper, n. sp. *6*, *8*, Sagittal sections showing uniformity of coiling and tunnel, the latter lying almost wholly in the plane of the section, ×100. *7*, Axial section, ×100. Kinkaid formation, bed 5, Johnson County, Illinois. (p. 86)

9, *11*—*Millerella kinkaidensis* Cooper, n. sp. Sagittal and axial sections, the latter showing the relatively long axis and modified keel-like margin, ×100. Kinkaid formation, bed 5, Johnson County, Illinois. (p. 86)

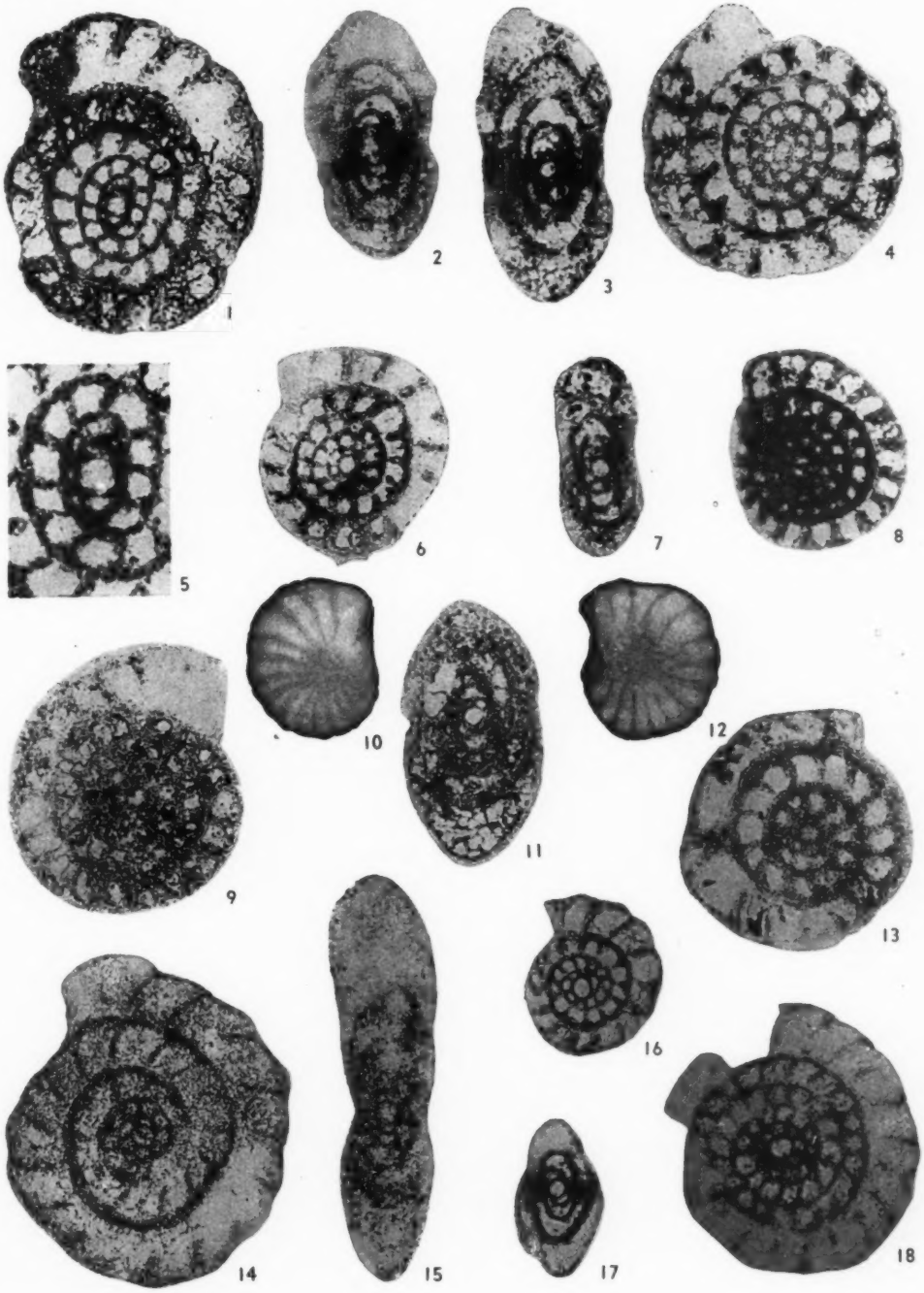
10, *12*—*Millerella* sp. External views of two specimens, ×60. (p. 83)

13—*Millerella* cf. *M. pinguis* Thompson. Sagittal section, ×100. Dornick Hills group, sec. 12, T. 3 S., R. 2 E., Carter County, Oklahoma. (p. 83)

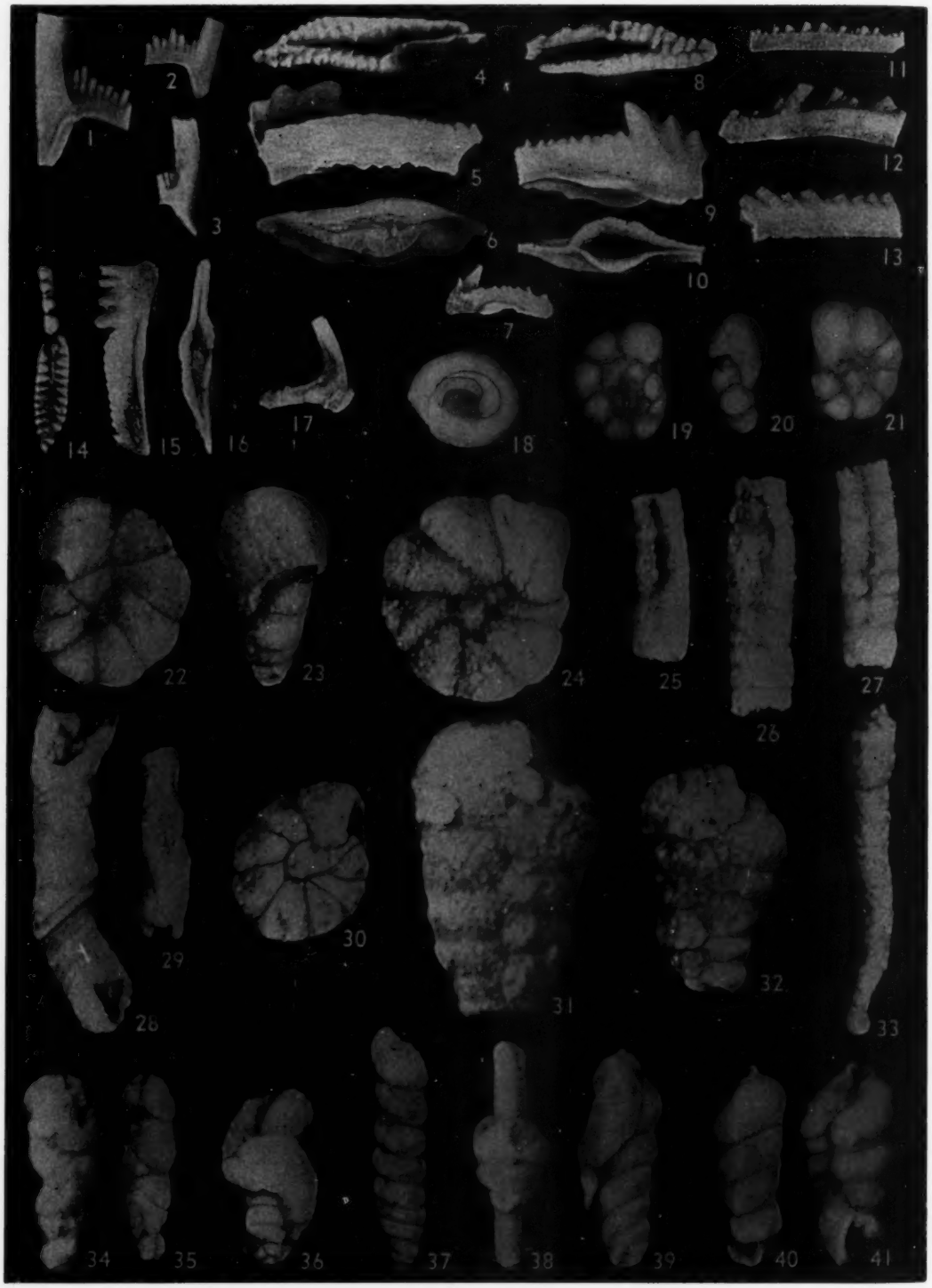
14–15—*Millerella marblensis* Thompson. Sagittal and axial sections, ×100. Same horizon and locality as fig. 13. (p. 83)

16–17—*Millerella advena* Thompson. Sagittal and axial sections, the latter showing inflated character and eccentric coiling of early volution, ×100. Lower Dornick Hills group, NW. ¼, NW. ¼, NE. ¼, sec. 16, T. 6 S., R. 2 E., Carter County, Oklahoma. (p. 83)

18—*Millerella inflecta* Thompson. Sagittal section from the Belden formation, bed 15, section P-15, Sweetwater Creek. Near Glenwood Springs, Colorado, ×100. (Thompson, 1945, p. 44, pl. 1, fig. 5.) (p. 83)



Cooper, Carboniferous *Millerella*



Cooper, Chester Conodonts and Foraminifera

Texas and the Mud Springs Mountains in central New Mexico. Later, Thompson (1944, p. 420) discovered the genotype species, *M. marblensis*, in the Brentwood limestone at the well-known type section of the Morrow group in northwestern Arkansas, and defined the zone of *Millerella* as that part of the stratigraphic section containing this fusuline to the exclusion of the normal long-axis forms. He also stated that

> It is entirely possible, if not probable, that species of *Millerella* or of a closely allied ancestral genus of fusulinids will be found in rocks of Mississippian age.

Later (1945, p. 42) he stated that

> All fusulinids so far discovered in the Belden formation (Idaho) are referable to the genus *Millerella*, which was originally described from the upper part of the Marble Falls limestone of Texas. Congeneric species are known to occur stratigraphically from near the base of the Morrowan series to near the top of the Pennsylvanian system. It is probable that further study will demonstrate the occurrence of *Millerella* in rocks older than Morrowan.

Endothyra has long been considered by some as the progenitor of the fusulinids (Galloway, 1933, pp. 388, 393; Dunbar and Henbest, 1942, p. 52) but most fusuline students have considered that the true Fusulinidae were confined to the Pennsylvanian and Permian. However, the recognition of *Millerella* in zones of the upper Chester in the type area demonstrates conclusively the occurrence of true fusulines in Mississippian rocks as Thompson predicted.

The thin sections of Chester *Millerella* were shown to Dr. Thompson at the Pittsburgh meeting of the Geological Society of America, and they were later sent to him for direct comparison with his described material. He states that "I have compared the specimens you sent me with all other similar forms I have in the laboratory. So far as I can tell they are more closely similar to the types of *Millerella inflecta* from the Belden formation of northwest Colorado."[1]

There are, however, some important and easily recognized differences between the Chester forms (pl. 19, figs. 1–12) and those previously described (pl. 19, figs. 13–18), consequently the older forms are described as new species. These distinguishing features are as follows:

1. The very strongly rounded periphery.
2. The relatively short, straight septa rapidly widening near the outer wall and producing a structure which is Δ-shaped in cross section (see sagittal sections), in contrast to the thin,

[1] Personal communication, January 27, 1946

EXPLANATION OF PLATE 20

FIGS. *1–3—Prioniodus scitulus* Branson and Mehl. Lateral views, ×20. (p. 92)
4–10—Cavusgnathus cristata Branson and Mehl. Oral, aboral, and lateral views; *4–6, 8–10*, ×20; *7*, ×30. (p. 91)
11–13—Hindeodella sp. Lateral views; *11*, ×20; *12, 13*, ×30. (p. 91)
14–16—Taphrognathus varians Branson and Mehl. Oral, lateral and aboral views, ×30. (p. 92)
17—Ligonodina cf. *L. levis* Branson and Mehl. Lateral view, ×30. (p. 91)
18—Glomospira disca Cooper, n. sp. Lateral view of holotype, ×60. (p. 87)
19–23—Endothyra excentralis Cooper, n. sp. *19, 21*, Lateral views and *20*, aperatural view of a young specimen; *22*, lateral view of holotype showing involute right side and greatly enlarged final chamber; *23*, apertural view of holotype. ×60. (p. 88)
24, 30—Endothyra acuta Cooper, n. sp. Lateral views, ×60. *24*, Holotype, showing umbilicus, depressed sutures, and sharply curved outer margin of chambers, bed 5. *30*, Smaller specimen showing highly arched aperture, bed 4. (p. 88)
25–27—Hyperammina cf. elongata clavulata Howchin. Lateral views of three fragmentary specimens, ×60. (p. 88)
28, 29—Hyperammina sp. Lateral views, ×60. (p. 89)
31, 32—Palaeotextularia asper Cooper, n. sp. Lateral views, ×60. *31*, Holotype. (p. 89)
33—Hyperammina cf. *H. glabra* Cushman and Waters. Lateral view of a nearly complete specimen, with initial chamber, ×50. (p. 89)
34–41—Trepeilopsis mississippiana Cooper, n. sp., Lateral views, ×60. *36, 39, 41*, Specimens showing tube bent back over earlier whorls; *38*, specimen coiled about a *Productus* spine; *37*, regular coils without development of straight portion. *34, 35*, from bed 1; *36, 38, 40, 41*, beds 5, 6; *37*, bed 7; and *39*, bed 4. *40, 41*, Two views of the holotype, showing wide, flaring aperture. *34, 35*, Two views of a single specimen. (p. 87)

more strongly curved septa of Pennsylvanian species.
3. The eccentricity of coiling, particularly in earlier volutions.
4. The modified hour-glass shape as visible in axial sections and the variation in degree of concavity of the two sides.
5. The endothyroid juvenarium of some species.

Based upon differences of size of proloculum, height of volutions, form ratio, and septal count, three new species are recognized in the Kinkaid fauna, namely *M. chesterensis* (pl. 19 figs. 1–5), *M. zelleri* (pl. 19, figs. 6–8) and *M. kinkaidensis* (pl. 19, figs. 9, 11). In general the Chester species are intermediate in form between the two extremes from the Pennsylvanian, namely, *M. marblensis* and *M. adrena* (see sagittal sections), having thicker shells than the former and lacking the inflated umbilical area of the latter. While the number of chambers per volution are about the same, the shorter, thicker septa of the Mississippian forms result in proportionally smaller chambers.

Millerella (species undescribed) from the Pitkin (upper Chester) of Arkansas has been reported by Henbest (1946). Representatives of the genus are also known to occur with Chester species of *Archimedes* and trilobites in beds of the Amsden formation in Wyoming (Zeller, 1946, personal communication).

In addition to the fusulines several genera of smaller Foraminifera are present in the Kinkaid microfauna (pl. 20, figs. 23–26). There are two new species of *Endothyra*, one of which, *E. acuta*, is suggestive of *E. whitesidei* Galloway and Ryniker, known heretofore from the Atoka of Oklahoma and the Marble Falls of Texas. The other is similar to *E. media* Waters, *E. rothrocki*, Harlton and *E. distenta* H. J. Plummer, from horizons in Oklahoma and Texas well above the Morrow zone and considerably younger than the Kinkaid. The flattened cylindrical forms with the irregularly spaced constrictions marking successive chambers closely resemble those from the Johns Valley shale of Oklahoma described as *Hyperammina elongata clavatula* Howchin by Harlton (1933, p. 8). A species of *Palaeotextularia* is not like the Johns Valley species. The extremely irregularly coiled *Trepeilopsis* is abundant and shows the variable nature of these forms. This genus is known to occur as low as the Chouteau (or Rockford), although described species are restricted to the Pennsylvanian. Significant is the absence of such characteristically Pennsylvanian genera as *Polytaxis*, *Tetrataxis*, *Endothyranella*, and *Reophax*.

Chester and Morrow conodont literature consists of only one paper for each of these subdivisions (Branson and Mehl, 1940 and Harlton, 1933). The conodonts in the Kinkaid are strongly Mississippian in character containing none of the typically Pennsylvanian forms described by Harlton from the Johns Valley. The two species of *Prioniodus*, *P. scitulus* and *P. varians*, are not known from beds younger than Chester. A common Pennsylvanian genus, *Cavusgnathus*, is represented by *C. cristata* which is easily distinguished from younger species. The specimens of *Hindeodella*, while not identifiable specifically, possess denticulated bars similar to those described from the Caney shale. A species of *Taphrognathus*, not known heretofore above the Keokuk, gives a distinct Mississippian aspect to the Kinkaid fauna.

The ostracodes are of the greatest value for determining the age of this fauna. The literature contains two fairly complete papers describing Kinkaid ostracodes (Croneis and Thurman, 1938 and Cooper, 1942) and several additional papers describe other Chester faunas. Information on Lower Pennsylvanian ostracodes is contained largely in papers by Roth (1929) and Harlton (1929, 1933).

Plate 21 shows such typical upper Chester species as *Balantoides reticulatus* Croneis and Thurman (figs. 1–3), the three species of *Bairdia*, *B. golcondensis* Croneis and Gale (figs. 25, 26), *B. attenuata* (figs. 27, 28), and *B. impendere* Cooper (figs. 29, 30), *Beyrichiopsis thori* Coryell and Johnson (fig. 13), and the two species of *Ectodemites*, *E. planus* Cooper (figs. 9–12) and *E. tumida* Cooper (figs. 14–16). However, the *Cornigella* (figs. 4–6) is indistinguishable from *C. tuberculospinosa* (Jones and Kirkby) listed by Harlton as *C. pushmatahensis* in his Johns Valley fauna which has a long range in the Pennsylvanian. Also *Amphissites insignis* Corneis and Thurman (figs. 19–22), differs

little from *A. margini*ferus Roth from the Union Valley and Wapanucka formations of Oklahoma.

Glyptopleurina iniqua (pl. 22, fig. 35) and *Hollinella radiata* (Jones and Kirkby) (figs. 20–23) are typical, easily recognized, and range no higher than the Chester. However, without close examination *Glyptopleura similis* Croneis and Funkhouser (figs. 32–34) might be confused quite easily with *G. coryelli* Harlton which has a long range in the Pennsylvanian. The species of *Healdia* are characteristically Chester.

Other good Chester markers, are *Glyptopleura tyri* Coryell and Johnson (pl. 23, figs. 9–11), *Perprimitia funkhouseri* Croneis and Thurman, (figs. 15–17), *Polytylites quincollinus* Harlton (fig. 25), and *Sargentina crassimarginata* Cooper (figs. 30–34). However, the reversed forms of *Sansabella harrisi* Croneis and Funkhouser (figs. 26–29) might easily be mistaken for *S. carbonaria* Cooper from the Pennsylvanian.

In summary, the fauna described is from the youngest Mississippian beds in the type area, which can be studied in connection with the Mississippian-Pennsylvanian contact. While predominantly Chester, the microfauna reflects other Chester faunal and sedimentological characteristics in that it heralds the approaching Pennsylvanian by showing a distinct break from the Middle Mississippian, while at the same time containing some early Pennsylvanian elements. All of the fauna, with the exception of the foraminifer *Trepeilopsis* and the ostracode *Hollinella radiata* show a complete lack of Middle or Lower Mississippian affinity, while most of the Foraminifera, including the fusuline *Millerella*, and some ostracodes and conodonts have a distinctly Pennsylvanian character.

SYSTEMATIC DESCRIPTIONS

Order FORAMINIFERA d'Orbigny, 1826
Family FUSULINIDAE Möller, 1878
Genus MILLERELLA Thompson, 1942

Millerella Thompson, 1942, Am. Jour. Sci., vol. 240, no. 6, p. 404.—Thompson, 1944, Kansas Geol. Survey, Bull. 52, p. 419.—Thompson, 1945, idem., Bull. 60, p. 40.

Shell disc-shaped, periphery angular to rounded, usually completely planispiral, but some species may have an endothyroid juvenarium while others have only slight irregularities in coiling; volutions 4 to 7, completely involute to slightly evolute; evolute species depressed or concave in polar area (umbilicate) and convex in involute forms; diameter one-fourth to one-half millimeter, axis usually one-fourth to one-third the diameter; spirotheca thin and believed to possess three walls, septa thin and long to short and thick (Δ-shaped); proloculum very minute; tunnel and chomata usually well developed.

The above generic description is essentially that of Thompson (1942, p. 404) but modified to include many subsequently described species, including those from the Kinkaid. The latter are entirely consistent generically with the Pennsylvanian forms and differ only in those minor structural features which are usually considered specific.

MILLERELLA CHESTERENSIS Cooper, n. sp.
Plate 19, figures 1–5

Shell very small, discoidal, periphery rounded; juvenarium endothyroid, essentially planispiral; spirotheca and septa thick, the latter almost Δ-shaped in section, essentially straight, but directed forward making an angle of about 65°, on the average, with spirotheca; coiling elongate about juvenarium, resulting in an elongate peripheral outline in sagittal section; last volution partially evolute, forming a slightly umbilicate shell, the degree of concavity being unequal on opposite sides.

Data on shell measurements and septal counts is shown in table 1.

M. chesterensis differs from *M. marblenensis* Thompson in its smaller size, shorter, thicker septa, larger tunnel angle, rounded periphery (see axial sections) and is almost completely involute. *M. inflecta* Thompson, although quite similar in axial section has thinner spirotheca and septa, greater regularity of coiling, a nonendothyroid juvenarium, and larger proloculum, diameter and form ratio.

Kinkaid formation, bed 5, Johnson County Illinois.

TABLE 1.—STATISTICAL DATA FOR *M. chesterensis*, MEASUREMENTS IN MICRONS

Spec.[1]	Septal Count					Prol. Diam.	L.	W.	Ratio	Ht. Volutions					Tunnel Angle
	1	1	3	4	5					1	2	3	4	5	
1	—	11	14	18	114	20	—	—	—	13	20	27	40	—	
2	—	9	13	15	17	20	—	—	—	—	20	27	40	53	
3	—	—	—	—	—	20	160	430	1:0.37	13	40	53	60	61	21°
4	—	—	—	—	—	20	140	350	1:0.40	13	20	27	40	60	21°

[1] Specimens 1 and 2 are sagittal sections, 3 and 4 are axial sections. Specimen 1 is illustrated in pl. 19, figs. 1, 5; 2, fig. 4; 3, fig. 4; and 4, fig. 2.

MILLERELLA KINKAIDENSIS Cooper, n. sp.
Plate 19, figures 9, 11

Shell small, discoidal; periphery subrounded, involute, and only slightly umbilicate; walls thick, septa short, thick and slightly curved; chambers small and about as wide as high (see sagittal section); proloculum relatively large; juvenarium endothyroid. Data on shell measurements and septal counts is shown in table 2.

M. kinkaidensis has a longer axis and larger proloculum than the other two Kinkaid species of *Millerella*. It differs from Pennsylvanian species much as the other Kinkaid species do.

Kinkaid formation, bed 5, Johnson County, Illinois.

MILLERELLA ZELLERI Cooper, n. sp.
Plate 19, figures 6–8

Shell very minute, regularly coiled, septa very short, thick, tapered, closely spaced, forming rather small chambers; periphery rounded; axial regions slightly and nearly equally umbilicate, completely involute; juvenarium endothyroid, but nevertheless the coiling is regular.

Data on shell measurements and septal counts is shown in table 3.

M. zelleri is distinguished from *M.*

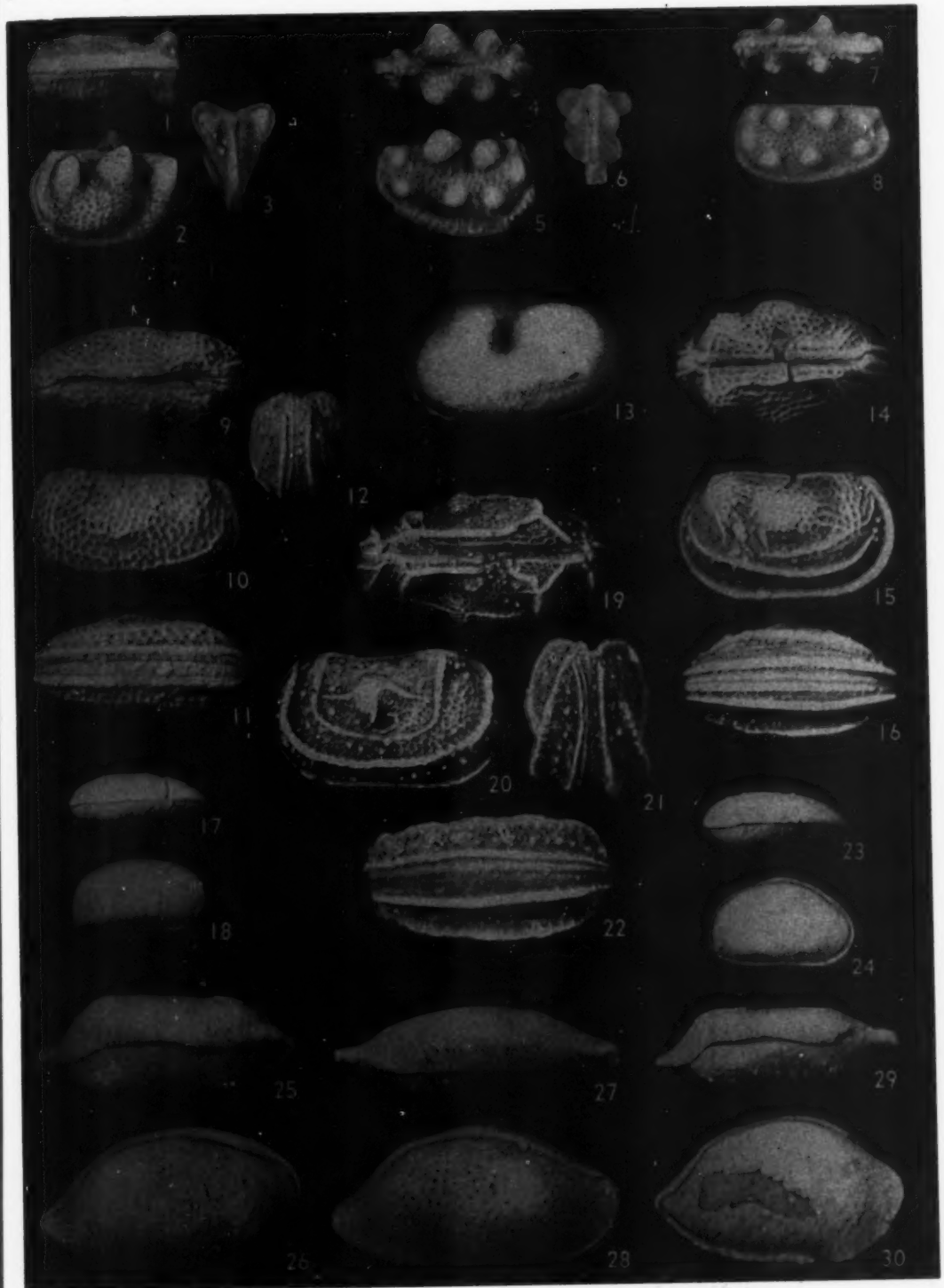
TABLE 2.—STATISTICAL DATA FOR *M. kinkaidensis*, MEASUREMENTS IN MICRONS

Spec.[2]	Septal count				Diam. Proloc.	L.	W.	Ratio	Ht. volutions					Tunnel angle
	1	2	3	4					1	2	3	4	5	
1	8	13	16	20	26	—	—	—	13	20	27	46	46	—
2	—	—	—	—	23	18	36	1:0.50	—	20	33	46	74	±30°

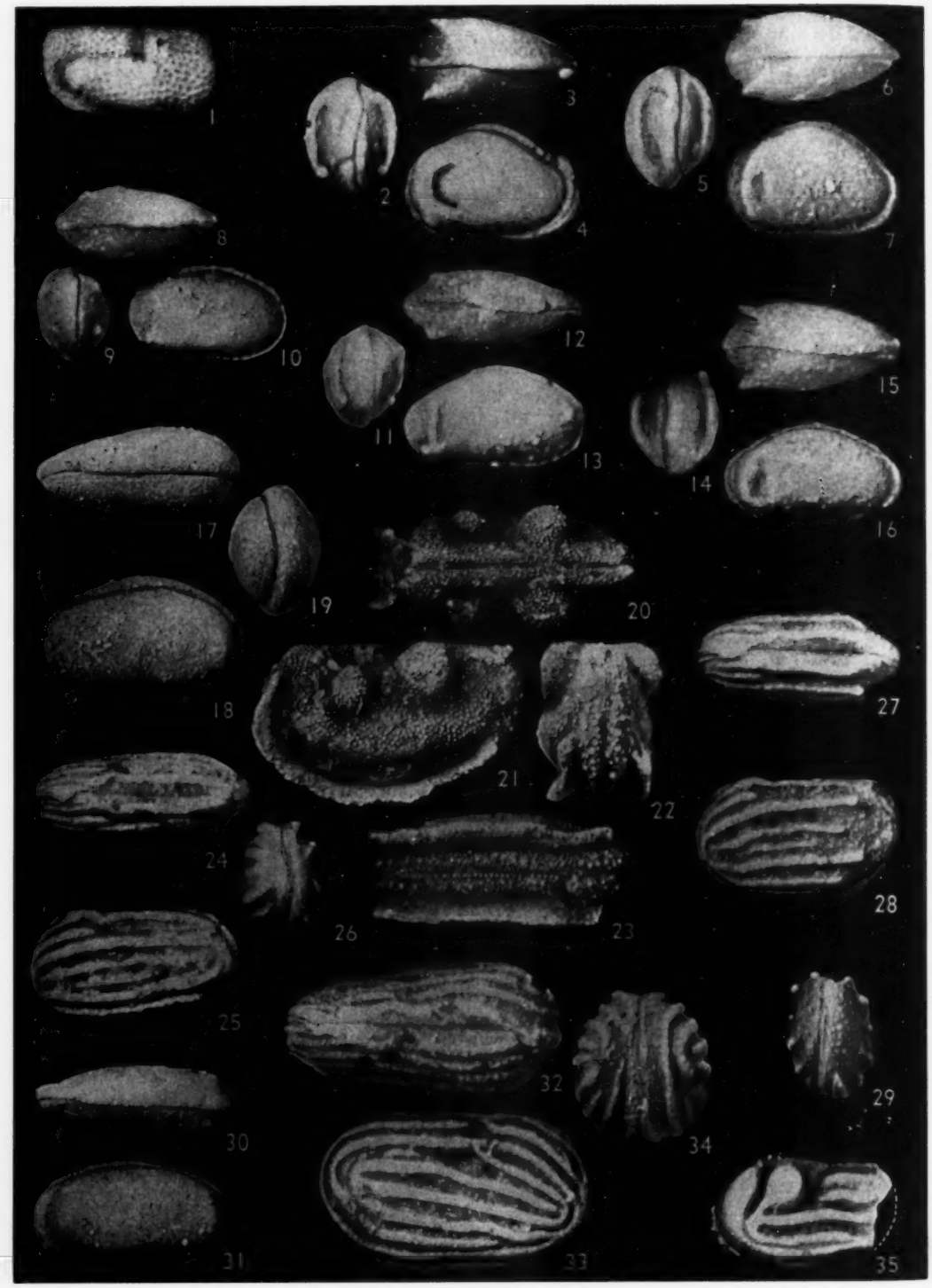
[2] Specimen 1 is a sagittal section, 2 an axial section. Specimen 1 is shown on pl. 19, fig. 9; 2, fig. 11

EXPLANATION OF PLATE 21

FIGS. *1–3—Balantoides reticulatus* Croneis and Thurman. Dorsal, lateral and end views, ×50. (p. 84)
4–6—Cornigella tuberculospinosa (Jones and Kirkby). Dorsal, lateral and end views, ×50. (p. 89)
7–8—Cornigella golcondensis (Croneis and Gale). Dorsal and lateral views, ×50. (p. 90)
9–12—Ectodemites planus Cooper. Dorsal, ventral, lateral and end views, ×40. (p. 84)
13—Beyrichiopsis thori Coryell and Johnson. Lateral view, ×40. (p. 84)
14–16—Ectodemites tumidus Cooper. Dorsal, lateral and end views, ×40. (p. 90)
17–18—Coryellites concava (Cooper). Dorsal and lateral views, ×40. (p. 89)
19–22—Amphissites insignis Croneis and Thurman. Dorsal, ventral, lateral, and end views of two specimens (fig. 19, is a single valve), ×30. (p. 84)
23–24—Coryellites portica Cooper, n. sp. Dorsal and lateral views, ×40. (p. 89)
25–26—Bairdia golcondensis Croneis and Gale. Dorsal and lateral views, ×40. (p. 84)
27–28—Bairdia attenuata Girty. Dorsal and lateral views, ×40. (p. 84)
29–30—Bairdia impendere Cooper. Dorsal and lateral views, ×40. (p. 84)



Cooper, Chester Ostracodes



Cooper, Chester Ostracodes

chesterensis by its thicker spirotheca, shorter and thicker septae, its regularity of coiling, and shorter axis. This is one of the smallest described species of *Millerella*.

Kinkaid formation, bed 5, Johnson County, Illinois.

Family AMMODISCIDAE Rhumbler, 1895
Genus GLOMOSPIRA Rzehak, 1888
GLOMOSPIRA DISCA Cooper, n. sp.
Plate 20, figure 18

Test minute, free, early volutions irregularly coiled, but tending to lie within plane of the last coil; tube increases regularly in diameter.

Diameter, 0.23 mm.; thickness, 0.12 mm.

G. disca is smaller and more regularly coiled than *G. siluriana* Ireland, nor is the coiling so irregularly developed as in *G. diversa* Cushman and Waters.

Kinkaid formation, beds 5, 6, Johnson County, Illinois.

Genus TREPEILOPSIS Cushman and Waters, 1928
TREPEILOPSIS MISSISSIPPIANA Cooper, n. sp.
Plate 20, figures 34–41

Test attached to *Productus* spines or free, coiled in a tight conical spiral in early volutions, later becoming a cylindrical coil, finally the tube bends down across the spiral coils in a broadly curved manner that is roughly **S**-shaped; aperture at end of tube, wide, somewhat flared.

Length (holotype), 0.52 mm.; diameter of tube in last whorl, 0.05 mm.; width of aperture, 0.056 mm.

TABLE 3.—STATISTICAL DATA FOR *M. zelleri*, MEASUREMENTS IN MICRONS

Spec.[3]	Septal count				Diam. Proloc.	L.	W.	Ratio	Ht. volutions					Tunnel angle
	1	2	3	4					1	2	3	4	5	
1	11	14	16	18	20	—	—	—	13	20	27	40	46	—
2	9	11	13	16	20	—	—	—	13	27	33	40	53	—
3	—	—	—	—	23	10	27	1:0.36	13	20	33	40	46	*Ca.* 10°

[3] Specimens 1 and 2 are sagittal sections, and 3 are axial section. Specimen 1 is shown on pl. 19, fig. 8; 2, fig. 6, and 3, fig. 7.

T. mississippiana differs from *S. grandis* Cushman and Waters by the marked curvature of the latter portion of the tube and from *T. spirans* (Cushman and Waters) by the flaring aperture. It can be separated from an undescribed Kinderhook species by the smaller size, tighter coiling, and the long taper of the latter.

EXPLANATION OF PLATE 22

FIGS. *1*—*Kirkbyella quadrata* Croneis and Gutke. Lateral view, ×50.
2–4—*Healdia sulcata* Cooper n. sp. Dorsal, lateral and end views of holotype, ×50. (p. 90)
5–7—*Healdia caneyensis* Harlton. Dorsal, lateral and end views, ×50. (p. 83)
8–10—*Healdia aequabilis* Cooper. Dorsal, lateral and end views, ×40. (p. 83)
11–13—*Healdia elliptica* Cooper. Dorsal, lateral and end views, ×50. (p. 83)
14–16—*Healdia tenuicosta* Cooper. Dorsal, lateral and end views, ×50. (p. 85)
17–19—*Cavellina ovatiformis* (Ulrich). Dorsal, lateral and end views, ×30.
20–23—*Hollinella radiata* (Jones and Kirkby). Dorsal, lateral, ventral and end views, ×30. (p. 85)
24–26—*Glyptopleura circumcostata* Cooper. Dorsal, lateral, and end views, ×40.
27–29—*Glyptopleura varians* Croneis and Funkhouser, ×40. *32*, *34*, Dorsal and end views. *33*, Lateral view of left valve of another specimen.
30–31—*Cavellina librata* Cooper. Dorsal and lateral views, ×40.
32–34—*Glyptopleura similis* Croneis and Funkhouser. Dorsal lateral and end views, ×40. (p. 90)
35—*Glyptopleurina iniqua* Cooper. Lateral view of broken valve, ×40. (p. 85)

Family ENDOTHYRIDAE Rhumbler, 1895
Genus ENDOTHYRA Phillips, 1845

A great variety of species has been assigned to this genus by various workers in this country and abroad, forms ranging from the almost completely evolute *E. gallowayi* Thomas, discoid forms such as *E. ammonoides* Brady and *E. subtilissima* Brady, to such involute species as *E. globula* (d'Eichwald). Many intermediate forms with varying degrees of involution exist, such as *E. ameradaensis* Harlton and *E. media* Waters. Others, partially evolute on one side and involute on the other include the well-known *E. baileyi* (Hall) and the genotype species, *E. bowmani* Phillips. The habit of coiling is also extremely variable, as shown by the regular planispiral of the very flat species to the very great excentricity of thick, bulbous forms exemplified by *E. baileyi*. However, the heterogeneity of the latter species is not so marked as was first supposed, as shown by Scott, Zeller and Nodine (1946), who demonstrate that it has a definite axis of coiling for each half volution. Several species now classified with *Endothyra* probably should be listed with the primitive fusuline *Millerella* Thompson (1942), such as *E. radiata* Brady, *E. globula* (d'Eichwald) (Harlton, 1927) and possibly *E. ornata* Brady to judge from its sagittal section.

ENDOTHYRA ACUTA Cooper, n. sp.
Plate 20, figures 24, 30

Shell medium sized, 8 chambers in last volution; periphery rounded; chambers large and somewhat arched at periphery due to deeply incised sutures as seen in lateral outline; septal angle somewhat less than normal, giving a "backward swing" appearance, especially in last three or four chambers; slightly biumbilicate, the left side being more evolute; apertural face abrupt, not in a plane normal to axis of coiling because the right side of the arch around the aperture has developed faster than the left, making it possible to view aperture from the left side.

Greatest diameter (holotype), *ca.* 0.56 mm.; diameter, last chamber, *ca.* 0.20 mm.; axial thickness, *ca.* 0.19 mm. (These dimensions are approximate as last chamber of holotype is crushed.)

E. acuta resembles *E. whitesidei* Galloway and Ryniker in shape of chambers, but lacks the marked evolute character of the latter. It also has a larger aperture and consequently a higher apertural face than the Pennsylvanian species.

Kinkaid formation, beds 4 and 5, Johnson County, Illinois.

ENDOTHYRA EXCENTRALIS Cooper, n. sp.
Plate 20, figures 19–23

Shell small, thick, 6 to 8 chambers in last volution; periphery rounded; chambers bulbous, especially the final one which is much thicker proportionally than the others; sutures distinct and incised; right side completely involute, left somewhat umbilicate; aperture a crescent-shaped slit located at the base of chamber, extending from the center down the umbilicate side.

Greatest diameter (holotype), 0.48 mm.; diameter last chamber, 0.26 mm.; axial thickness, 0.16 mm.

E. excentra is similar to *E. media* Waters, *E. ovata* Waters, *E. distenta* H. J. Plummer, and *E. rothrocki* Harlton, but the shape of the aperture differentiates it from the first three and the central position of the aperture distinguishes the latter.

Kinkaid formation, beds 4 and 5, Johnson County, Illinois.

Family ASTRORHIZIDAE Brady, 1881
Genus HYPERAMMINA Brady, 1878
HYPERAMMINA cf. H. ELONGATA CLAVATULA HOWCHIN
Plate 20, figures 25–27

Hyperammina elongata clavatula Howchin, 1888, Royal Micr. Soc. Jour., p. 535, pl. 8, figs. 1, 2; Mississippian limestones of England.—Harlton, 1927, Jour. Paleontology, vol. 1, p. 16, pl. 1, figs. 1a, b; Upper Caney shale, Oklahoma.—Harlton, 1933, idem, vol. 7, p. 8, pl. 1, figs. 1a–e; John Valley shale, Okla.

The Kinkaid specimens cannot be distinguished from those occurring above and below the Mississippian-Pennsylvanian boundary in Oklahoma. However, they lack the pointed proloculum of *H. elegantissima* H. J. Plummer, and *H. spinescens* Cushman and Waters and the globular proloculum of *H. bulbosa* Cushman and Waters, reported by Mrs. H. J. Plummer from younger beds in Texas.

Kinkaid formation, bed 7, Johnson County, Illinois.

HYPERAMMINA cf. H. GLABRA Cushman and Waters
Plate 20, figure 33

Hyperammina glabra Cushman and Waters, 1927, Cushman Lab. Foram. Research Contr., vol. 3, p. 146, pl. 26, fig. 1; upper Strawn, Texas.—Cushman and Waters, 1930, Texas Univ. Bull. 3019, p. 33, pl. 2, figs. 1–3; Cisco group, Texas.

This Kinkaid specimen seems to be similar in most respects to the species from the Pennsylvanian of Texas in its small proloculum with a slight constriction above it, followed by a long gradually widening tube that is straight to slightly bowed.

Kinkaid formation, bed 4, Johnson County, Illinois.

HYPERAMMINA sp.
Plate 20, figures 28, 29

The two large fragments apparently belong to this genus but the absence of a proloculum precludes specific designation.

Kinkaid formation, bed 7, Johnson County, Illinois.

Family TEXTULARIDAE d'Orbigny, 1846
Genus PALAEOTEXTULARIA Schubert, 1920
PALAEOTEXTULARIA ASPER Cooper, n. sp.
Plate 20, figures 31, 32

Test biserial, chambers flat, elongate, increasing in size in a regular manner, with sutures parallel and indistinct; aperture a low, central slit at base of apertural face; walls granular.

The biserial arrangement is similar to *Palaeotextularia* sp. Harlton from the Johns Valley shale, but the Kinkaid form is more tenuous and has a more slender aperture. *P. asper* is more stocky than *P. grahamensis* (Cushman and Waters) and has a more elongate aperture but is without the globular chambers of the latter.

Kinkaid formation, bed 5, Johnson County, Illinois.

Subclass OSTRACODA Latreille, 1801

All ostracode species of this fauna are illustrated (pls. 21–23) but descriptions are presented only for those that are new. Descriptions of the others may be obtained readily from the published reports listed in the references. Several short discussions indicate the differentiation of some previously described Kinkaid species from similar Pennsylvanian forms.

Family BAIRDIIDAE Sars, 1887
Genus CORYELLITES Kellett, 1936
CORYELLITES CONCAVA (Cooper)
Plate 21, figures 17, 18

Bythocypris concava Cooper, 1941, Illinois Geol. Survey Rept. Inv. 77, p. 28, pl. 3, figs. 3–6; Vienna, Menard and Kinkaid formations, Illinois.

This species described from the upper Chester should have been classified under *Coryellites* for the reasons set forth in the report on the Pennsylvanian ostracodes of Illinois (Cooper, 1946, p. 55).

CORYELLITES PORTICA Cooper n. sp.
Plate 21, figures 23, 24

Carapace ovate, dorsal and ventral margins unequally arched; ventral margin straight; ends rounded; posterior considerably higher and thicker than anterior; overlap moderate and uniform around all margins.

Length, 0.57 mm.; height 0.35 mm.; thickness, 0.23 mm.; form ratio, 1.63.

C. portica resembles *C. subelliptica* (Upson) and *C. johnsoni* (Upson) but is more highly arched and has a more nearly perpendicular posterior margin than these Pennsylvanian species.

Kinkaid formation, bed 1, Johnson County, Illinois.

Family DREPANELLIDAE Swartz, 1936
Genus CORNIGELLA Warthin, 1930
CORNIGELLA TUBERCULOSPINOSA (Jones and Kirkby)
Plate 21, figures 4–6

(For synonomy see Cooper, 1946, p. 78.)

This multinodose form appears in several Chester and Pennsylvanian ostracode zones. The Kinkaid specimens are indistinguishable from those of the Pennsylvanian, typically possessing an elongate, but blunt spinelike node anterodorsally, behind which is another similar but shorter node. All other nodes (there is usually a total of 6 to 8) are

smaller than two near the dorsum. The only other Chester species, *C. golcondensis* (Croneis and Gale), is considerably more elongate.

Kinkaid formation, bed 1, Johnson County, Illinois

Genus VARIX Cooper, n. gen.

Carapace subovate, cardinal angles subequal, with well-defined "swing," free margin (and part of dorsal margin) bordered by a well-defined ridge, central portion marked by irregular, more or less continuous ridges.

Genotype, *Varix propria* Cooper n. sp.

Varix conforms to other genera of the family in its shape and bordering ridge, but the irregularity of its other ornamental features distinguishes it from its near relatives.

VARIX PROPRIA Cooper, n. sp.
Plate 23, figures 12–14

Carapace elongate, subovate, hinge line straight, ends rounded, ventral margin slightly concave; cardinal angles very unequal, the anterior being about 90°, the posterior markedly acute; free margins and part of dorsal margin bordered by a prominent ridge of uniform height and width; central portion of shell marked by an irregular ridge of similar character, subrectangular to subelliptical, the axis of "ellipse" parallel to ventral margin, with a continuation of the ridge inside the "ellipse"; one side of the central portion of the ridge develops into a loop anterior to a shallow circular pit located near midlength; the loop ends posterior to the pit in a small circular node; near the center of the anterodorsal margin the outer loop rises above the hinge line; articulation simple and apparently without overlap.

Length (of holotype), 0.49 mm.; height, 0.38 mm.; form ratio, 1.44.

Kinkaid formation, bed 5, Johnson County, Illinois.

Family GLYPTOPLEURIDAE Girty, 1910
Genus GLYPTOPLEURA Girty, 1910
GLYPTOPLEURA SIMILIS Croneis and Funkhouser
Plate 22, figures 32–34

Glyptopleura similis Croneis and Funkhouser, 1938, Denison Univ. Bull., Jour. Sci. Lab., vol. 33, p. 352, pl. 10, fig. 4.—Cooper, 1941, pl. 7, figs. 23, 24; Clore formation, Illinois.

This species has a rib pattern somewhat similar to *G. coryelli* Harlton in that the rib which is just above the pit bifurcates anteriorly. However, the two species may be distinguished by their differences in lateral outline, the Pennsylvanian species being more quadrate, or not as subelliptical as in *G. similis*.

Kinkaid formation, beds 4–6, Johnson County, Illinois.

Family HEALDIIDAE Harlton, 1933
Genus HEALDIA Roundy, 1926
HEALDIA SULCATA Cooper, n. sp.
Plates 22, figures 2–4

Carapace short, tumid, lateral outline subelliptical; dorsal margin strongly convex, ventral margin nearly straight; posterior ridge curved and directed strongly toward posterior, rising but little above curvature of shell as seen in dorsal view; ridge bordered on anterior side by a deeply incised semicircular furrow of uniform width; overlap prominent around dorsal and ventral margins, each valve developed at ends to produce a slightly incised articulation posteriorly and in irregular flare or "frill" on anterior; surface smooth except for furrow.

Length, 0.52 mm.; height, 0.36 mm.; thickness, 0.29 mm.

H. sulcata is readily distinguished by the unusual furrow in front of the usual posterior ridge which is typical of the genus. However, this should not be confused with the depressed area of *Incisurella* or the trough formed by a row of pits in *Cribroconcha*. Except for the furrow *H. sulcata* is much like many other species such as *H. ornata* Morey and *H. ovoidea* Cooper from the Chester and *H. ehlersi* Bradfield and *H. nucleolata* Knight from the Pennsylvanian.

Kinkaid formation, beds 4–6, Johnson County, Illinois

Family KIRKBYIDAE Ulrich and Bassler, 1923
Genus ECTODEMITES Cooper, 1941
ECTODEMITES TUMIDUS Cooper
Plate 21, figures 14–16

Ectodemites tumidus Cooper, 1941, Illinois Geol. Survey Rept. Inv. 77, p. 51, pl. 10, figs. 1–3.

E. tumidus, known only from the Kinkaid,

resembles *E. plummeri* Cooper from the Marble Falls (Texas) and Ferdinand (Indiana) formations of Morrow age, in both size and general shape. However, the ridges of the younger species are more prominent, the reticulations coarser, and the kirkbyan pit larger and almost centered under the medial node. The inner ridge of *E. tumidus* is especially prominent compared to that of *E. plummeri*.

Kinkaid formation, beds 4–6, Johnson County, Illinois.

Family KLOEDENELLIDAE Ulrich and Bassler, 1923

Genus SANSABELLA Roundy, 1926

SANSABELLA HARRISI Croneis and Funkhouser

Plate 23, figures 26–29

Sansabella harrisi Croneis and Funkhouser, 1938, Denison Univ. Bull., Jour. Sci. Lab., vol. 33, p. 334, pl. 9, figs. 7, 8; Clore formation.—Cooper, 1941, Illinois Geol. Survey, Rept. Inv. 77, p. 60, pl. 13, figs. 15, 16; Clore and Kinkaid formations.

Sansabella thurmani Croneis and Funkhouser, 1938, *op. cit.*, p. 336, pl. 9, figs. 11, 12; Clore formation.

Like many other species of *Sansabella* this one is found in two forms, one of which is the mirror image of the other. It resembles *S. carbonaria*, from the Missouri series, but is not so elongate, nor does it have the angulated line of concrescence of the Pennsylvanian species. The younger form also has a more prominent pit.

Kinkaid formation, bed 4, Johnson County, Illinois.

Genus SARGENTINA Coryell and Johnson, 1939

SARGENTINA CRASSIMARGINATA (Croneis and Thurman)

Plate 23, figures 30–34

Sulcella crassimarginata Croneis and Thurman, 1938, Denison Univ. Bull., Jour. Sci. Lab., vol. 33, p. 328, pl. 7, figs. 15, 16; Kinkaid formation.

Sargentina crassimarginata, Cooper, 1941, Illinois Geol. Survey, Rept. Inv. 77, p. 39, pl. 6, figs. 9, 10; Kinkaid formation.

This common Kinkaid species is somewhat larger than representatives of the genus which occur rather high in the Pennsylvanian system. *S. tumida* Cooper from the "Centralia" zone may be distinguished by its greater ellipticity and curved hingeline and *S. elongata* Cooper from the Little Vermilion is more elongated and has a hinge margin that is more nearly straight.

Kinkaid formation, bed 4, Johnson County, Illinois.

CONODONTS Pander, 1856

Genus CAVUSGNATHUS Harris and Hollingsworth, 1933

CAVUSGNATHUS CRISTATA Branson and Mehl

Plate 20, figures 4–10

Cavusgnathus cristata Branson and Mehl, 1940, Denison Univ. Bull., Jour. Sci. Lab., vol. 35, p. 177, pl. 5, figs. 26–31; Caney shale, Oklahoma.

This large species with its high platform and deep trough, and the "cockscomb" development on the oral side is confined to Chester and younger formations. It is much larger than the Pennsylvanian species, and there appears to be little difference between Caney and Kinkaid specimens, except that those from the latter are slightly larger (1.5 mm. and 2.0 mm., respectively).

Kinkaid formation, bed 4, Johnson County, Illinois.

Genus HINDEODELLA Ulrich and Bassler, 1926

HINDEODELLA sp.

Plate 20, figures, 11–13

This genus is represented only by fragments of bars which are not specifically determinable. However, three types of dentition are represented: 1, Large denticles alternating with groups of three smaller ones, and slightly inclined (fig. 11); 2, large denticles alternating with single small denticles, all sharply inclined (fig. 12); and 3, all large denticles sharply inclined to bar (fig. 13). Not enough specimens have been obtained to determine characters that might distinguish them from other Carboniferous species.

Kinkaid formation, beds 1, 4, 6, Johnson County, Illinois.

Genus LIGONODINA Ulrich and Bassler, 1926

LIGONODINA cf. L. LEVIS Branson and Mehl

Plate 20, figure 17

Ligonodina levis Branson and Mehl, 1941, Denison Univ. Bull., Jour. Sci. Lab., vol. 35,

p. 185, pl. 6, fig. 10; Keokuk formation, Missouri.

Although fragmentary, the Kinkaid specimen conforms to this Keokuk species with respect to the fairly heavy, slightly curved cusp, thin bar with thin, discrete denticles; projection probably slight judging from the scar remaining.

Kinkaid formation, beds, 5, 6, Johnson County, Illinois.

Genus PRIONIODUS Pander, 1856

PRIONIODUS SCITULUS Branson and Mehl

Plate 20, figures 1–3

Prioniodus scitulus Branson and Mehl, 1941, Denison Univ. Bull., Jour. Sci. Lab., vol. 35, p. 173, pl. 5, figs. 5, 6; Caney shale, Oklahoma.

This species with its erect cusp, lens-shaped in cross section, with large appressed denticles, free in upper half, and fluted projection, is typically Mississippian.

Kinkaid formation, beds 1, 4–6, Johnson County, Illinois

Genus TAPHROGNATHUS Branson and Mehl, 1941

TAPHROGNATHUS VARIANS Branson and Mehl

Plate 20, figures 14–16

Taphrognathus varians Branson and Mehl, 1941, Denison Univ. Bull., Jour. Sci. Lab., vol. 35, p. 182, pl. 6, figs. 27–41; Keokuk formation, Missouri.

The Kinkaid species is similar in all respects to that from the Keokuk, e.g., in size, shape of bar both orally and aborally, and shape and dentition of the blade.

Kinkaid formation, bed 1, Johnson County, Illinois

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EXPLANATION OF PLATE 23

FIGS. *1–4—Monoceratina celsalobata* Cooper. Dorsal and lateral views, ×50.
5–8—Monoceratina furcula Croneis and Gale. Dorsal, lateral, ventral and end views, ×50.

9–11—Glyptopleura tyri Coryell and Johnson. Dorsal, lateral and end views, ×40. (p. 85)
12–14—Varix propria Cooper, n. gen., n. sp. *12, 13*, Interior and lateral views of holotype; *14*, lateral view of a paratype, ×50. (p. 90)
15–17—Perprimitia funkhouseri Croneis and Thurman, Dorsal, lateral and end views, ×40. (p. 85)
18–20—Paraparchites nicklesi (Ulrich) Dorsal, lateral and end views, ×40.
21–24—Neokloedenella prima Croneis and Funkhouser. Dorsal, lateral, ventral and end views, ×30.
25—Polytylites quincollinus (Harlton) Lateral view, ×40. (p. 85)
26–29—Sansabella harrisi Croneis and Funkhouser. Dorsal and lateral views of reversed forms, ×40. (p. 91)
30–34—Sargentina crassimarginata Croneis and Thurman. Dorsal, lateral, ventral (right and left valves) and end views, ×40. (p. 91)

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A NEW UPPER DEVONIAN CONODONT FAUNA FROM IOWA

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ABSTRACT—A recently discovered shale is exposed in a small valley 1½ miles northeast of North Liberty, Iowa. This shale appears to have a discontinuous occurrence immediately or a few feet above the well known Cedar Valley limestone. It carries an abundant conodont fauna which in part is new. However, the genera represented, as well as many of the species, have been previously recorded from other localities and they indicate that this shale is referable to the Upper Devonian.

IN THE fall of 1945, a new shale outcrop was discovered in a small valley approximately 1½ miles northeast of North Liberty, in east-central Iowa. The shale is greenish-tan in color when wet, but gray when dry. It is slightly arenaceous and weathers readily. Samples of this shale were collected from a single five-foot vertical exposure at intervals of about one foot. Conodonts were found to be present throughout the entire section but are most abundant in the lower portion.

The valley wherein this shale occurs has been visited periodically by stratigraphers for many years and is well known. No shale has been previously reported, but Stainbrook and Ladd (1926, pp. 355–356) have called attention to the occurrence of some two feet of "yellow sub-dolomitic thinly bedded layers of [the] basal State Quarry member" in this valley. The shale in question occurs directly over thin-bedded brownish, slightly arenaceous dolomitic beds which may be the stratigraphic unit that has been described as basal State Quarry. However, in some localities the uppermost beds of the Cedar Valley limestone have a similar lithology.

The outcrop area of this shale is very small, the beds being discontinuously exposed along the immediate banks of a small intermittent stream for six or seven hundred yards. Here, the stream flows on the dolomitic, sandy, ferruginous strata which are either the top of the Cedar Valley or the base of the State Quarry. The shale crops out at stream level and upward for a maximum vertical exposure of no more than five feet. A thick drift deposit directly overlies the shale, and the zone of contact is a mixture of glacial debris and marine clay. About a third of a mile downstream (east) of the shale outcrop area, both the Cedar Valley limestone and the State Quarry formation are well exposed, though their contact is covered. The stratigraphic relationships of this recently discovered shale, the Cedar Valley limestone and the State Quarry formation are not entirely clear, but it is reasonably certain that the shale does occur either directly above or very close above the Cedar Valley. It may possibly belong to the basal part of the State Quarry formation.

The only other known occurrence of this shale is in a well drilled during March, 1946, at North Liberty, Iowa. In this well section, slightly more than 20 feet of conodont-bearing shale was encountered directly above the Cedar Valley formation. Through the courtesy of the Iowa Geological Survey, the well-cuttings of this shale have been made available for study. Examination of the conodonts in these samples establishes the presence of the genera *Ancyrodella*, *Palmatolepis*, and *Polygnathus*. These specimens, together with the general aspect of the conodont fauna and of the washed shale residue, indicate that the shale in the North Liberty well is almost certainly the same stratigraphic unit as that seen in outcrop 1½ miles northeast of the well location. The driller reported the presence of several feet of limestone above the shale horizon but unfortunately he saved no cuttings from that or higher zones, so the presence of the

State Quarry formation is inferred but not established. There is essentially no evidence in the well-cuttings of any thin-bedded, arenaceous dolomite below the shale. If such beds are present, they are very thin, for the two-foot sample from immediately below the shale is composed almost entirely of the characteristic clean gray limestone of the Cedar Valley formation.

The conodont fauna under consideration carries several genera which are well known from the Upper Devonian of many areas. Although not all of these generic forms are limited to the Upper Devonian, the association of representatives of *Ancyrodella*, *Ancyrognathus*, *Bryantodus*, *Hibbardella*, *Icriodus*, *Nothognathella*, *Palmatolepis*, and *Polygnathus*, all of which are represented in the collection at hand, leaves little doubt as to the age of the assemblage. On the basis of the known stratigraphic distribution of the foregoing genera, it appears that only by assigning this fauna to the Upper Devonian can incompatible associations be avoided.

There are many excellent conodont faunas in Iowa, though unfortunately they have received but little study. Conodonts have been obtained, however, from the Lime Creek, the Sheffield, and the Sweetland Creek formations, and also from an unnamed Upper Devonian shale which crops out near Middle Amana, Iowa. All these conodonts have been available for comparison, and the fauna under consideration does not seem to have any clear correlatives among the faunas mentioned above. Furthermore, it is distinctly younger than the conodonts described by Stauffer from the Cedar Valley formation in Minnesota. This last fact is in harmony with the presence of an unconformity long known to exist at the top of the Cedar Valley formation in the North Liberty area and elsewhere. In the fauna under consideration there is only a single specimen that is referable to any of the species described originally from the Cedar Valley limestone. About half-a-dozen forms are conspecific or compare closely with specimens from the Grassy Creek shale of Missouri. The majority of the hypotypes in this present fauna have correlatives in the Genesee beds and Rhinestreet shale of New York, and the Olentangy shale of central Ohio. An additional few forms were originally recorded from the New Albany shale of Indiana. The composite of these occurrences suggests an early Upper Devonian age.

In conclusion, the conodont fauna which occurs in the shale 1½ miles northeast of North Liberty, Iowa, is an abundant and varied one that is distinctly Devonian in aspect. In part the specimens are new forms, but the occurrence of many previously described species together with the genera represented, indicate that this newly discovered shale is most probably referable to the early part of the Upper Devonian.

Acknowledgment is made to the Iowa Geological Survey for generously providing transportation and field assistance in connection with this project. In addition, the interest and suggestions of Dr. H. G. Hershey and Mr. S. E. Harris of the Survey as well as of Professors A. C. Trowbridge and A. K. Miller of The State University of Iowa are gratefully acknowledged. The accompanying illustrations were made by Miss Nancy Emrick of Iowa City.

All the specimens described in this report are from a five-foot outcrop of shale located on the north side of a small stream in the NW ¼ sec. 8, T. 80 N., R. 6 W., Johnson County, Iowa, approximately 1½ miles northeast of North Liberty. The collection has been placed in the repository of the Geology Department at The State University of Iowa. All illustrations are ×30.

SYSTEMATIC PALEONTOLOGY

ANCYRODELLA GIGAS Youngquist, n. sp.

Plate 25, figure 23

This form is an exceptionally large representative of the genus *Ancyrodella*. The illustrated specimen is about 1.75 mm. in length, and it appears to be essentially complete. The posterior one-half of the platform proper is abruptly narrowed, pointed, and slightly recurved laterally and markedly curved aborally at its extremity. The blade, nearly one-half the length of the specimen, is high, does not contain distinctly individual denticles, and near its anterior end it is curved laterally. The carina extends from the junction of the blade and the plate to the posterior end of the specimen and consists of closely fused stout nodes. On

the two anterior lobes of the plate, small secondary carinae are present on the margin which is adjacent to the blade. Aborally, this species is keeled beneath the blade and at the posterior end of the platform. The keels become indistinct in the midportion of the platform where a small diamond-shaped escutcheon is present, the long axis of which corresponds to the long axis of the conodont. The ornamentation of the oral plate surface consists of stout nodes arranged in only semi-regular fashion.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Types.—State Univ. Iowa, 3358 (figured holotype), and 3359 (unfigured paratype).

ANCYROGNATHUS CAVA
Youngquist, n. sp.
Plate 24, figure 3

This species is closely related to *A. iowaensis*, n. sp. in that it possesses a carina which becomes modified anteriorly into a small but stout blade. The bifurcated carina which extends into the two posterior lobes of the plate is resolved into individual nodes and discrete denticles near and at the distal ends. In the figured specimen, the lobe that is normal to the long axis of the specimen is incomplete but enough of it is preserved to retain two small denticles in line with the carina. This species differs from *A. iowaensis*, however, in having the oral surface of the anterior-most lobe distinctly concave resulting in a platform much like that of some forms of *Polygnathus*. Aborally, the specimen is sharply keeled. However, a small triangular-shaped escutcheon or attachment scar is present, the apices of which are joined by the keels of the three lobes of the plate respectively.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Holotype.—State Univ. Iowa, 3360.

ANCYROGNATHUS IOWAENSIS
Youngquist, n. sp.
Plate 25, figure 22

There are several specimens of this unusual species of *Ancyrognathus* in the present collection. The largest of these is illustrated and appears to be complete in every detail except for the loss of the very tip of the ultimate denticle on the lateral lobe of the plate. Representatives of this species have the plate divided roughly into three lobes, two of which have a mutual long axis and make up most of the plate; the third lobe has its long axis approximately normal to that of the others. The third lobe is only slightly up-arched, whereas the plate proper, consisting of the other two lobes, is pronouncedly up-arched. A large carina extends the length of the plate proper and, at what is assumed to be the anterior end of the specimen, the carina is resolved into a small but stout blade which has two or three large denticles. This blade extends somewhat anteriorly beyond the plate margin. A smaller secondary carina extends from near the center of the plate to about halfway across the lateral lobe. The most unusual feature of this species is that the distal half of the lateral lobe is surmounted by three or four long, stout, laterally compressed denticles. The plate is of dark amber-colored material but the denticles are a light ivory-like color just as are most denticles of blade or bar type Devonian conodonts. Both the large and the small carinae are composed of a series of closely fused nodes. Near the extremities of each of the three plate lobes, the nodes of the carinae tend to become somewhat individual. Aborally, there are three keels which are most pronounced near the extremities of the lobes but which persist throughout, and directly underlie the carinae of the oral surface. At the junction of the three keels, there is a slight depression but no distinct escutcheon is present. Several fragmentary specimens referable to this species differ little, except that they are all somewhat smaller than the figured holotype.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Types.—State Univ. Iowa, 3361 (figured holotype) and 3362 (unfigured paratypes).

ANCYROGNATHUS IRREGULARIS Branson and Mehl
Plate 25, figure 21

Ancyrognathus irregularis BRANSON and MEHL, 1934 [1933], Missouri Univ. Studies, vol. 8, no. 3, p. 242, pl. 19, figs. 1, 2, 4, 10, 16.

Ancyrognathus irregularis BRANSON and MEHL, *in* BRANSON, 1944, Missouri Univ. Studies, vol. 19, no. 3, p. 162.

Ancyrognathus irregularis BRANSON, 1944, Missouri Univ. Studies, vol. 19, no. 3, p. 173.

The plate is thick, moderately up-arched and has no prominent or diagnostic surface ornamentation except for a carina on the oral surface which bifurcates near the center of the plate and extends into the two posterior lobes. The anterior extension of the carina is resolved into a small blade which does not extend beyond the plate proper. The oral surface of the plate is somewhat grooved in the vicinity of the blade. Aborally, the specimen is sharply keeled, the keels lying directly beneath the bifurcated carina. These keels are most prominent toward and at the extremities of the three lobes of the plate but diminish toward the center. Beneath the point of bifurcation of the carina, a small but distinct triangular-shaped escutcheon is present, the apices of which are joined to the keels of the three lobes, respectively.

Occurrence.—Grassy Creek shale and Louisiana limestone of Missouri, and an Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Hypotype.—State Univ. Iowa, 3363.

BRYANTODUS IOWAENSIS Youngquist, n. sp.
Plate 24, figure 18

The bar is strongly arched but not appreciably bowed. Aborally, both extremities of the bar are keeled, but toward the point of cusp insertion this keel diminishes and directly beneath the cusp there is a broad but very shallow excavation. The bar bears a pronounced node on both the inner and outer aboral margins directly in line with the long axis of cusp insertion. The outer bar surface bears a median lateral ridge. The inner oral surface of the bar is laterally expanded to a considerable degree and forms a platform or shelf-like structure. This platform bears no nodes or denticles except for the main ridge of denticles and the cusp which rise on its outer edge. The bar limbs are unequal in size, the posterior limb being the shorter. About nine denticles occur on the anterior bar limb and about six erupted denticles are present on the opposite limb. The denticles curve slightly inward, or sometimes outward, at their apices; they are partially to almost completely confluent and when properly lighted exhibit an occasional intercalated germ denticle. The cusp is very large and, like the denticles, somewhat compressed laterally and slightly sharpened at its anterior and posterior edges. This form is noteworthy for its exceptional size, being 2.16 mm. in length. The illustrated specimen appears to be complete except for the possible loss of one or two small denticles together with the posterior bar tip.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Holotype.—State Univ. Iowa, 3364.

BRYANTODUS MACHAERODUS
Youngquist, n. sp.
Plate 26, figure 5

This species has relatively short denticles which serve to further accentuate the large size of the cusp. The anterior bar limb carries at least five denticles which are partially fused and somewhat compressed laterally; the posterior bar limb has about six denticles some of which are discrete to the base. The cusp is essentially circular in cross section, very prominent, and projects aborally in the form of a node-like process on both the inner and outer aboral margins of the bar. Aborally beneath the cusp the bar is slightly excavated but toward the extremities it becomes keeled. The bar is up-arched and moderately bowed outward. The denticles and the cusp incline inward.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Holotype.—State Univ. Iowa, 3365.

BRYANTODUS sp. A
Plate 24, figure 6

The illustrated specimen is characterized particularly by the presence of two unusually large, closely fused laterally compressed denticles inserted midlength on the anterior portion of the bar. Also, a growth axis is present in each of these large denticles but does not appear in any of the other denticles or the cusp. The other denticles are short and are only slightly compressed laterally. Aborally, the bar is keeled except in the region of cusp insertion where a small escutcheon is present. The cusp proper is elliptical in cross section and has sharpened anterior-

posterior edges. The bar of the figured specimen is incomplete posteriorly

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3366.

BRYANTODUS sp. B
Plate 24, figure 12

The collection under consideration has several specimens possessing the general features of the form illustrated by figure 12. In each the anterior bar is preserved entire together with the cusp and a small portion of the posterior bar limb. The denticles are irregularly spaced and are not of uniform size, but the distinctive feature is that in general the denticles are larger near the distal end of the bar and that they become successively smaller toward the cusp. Aborally, the bar is keeled at and near the anterior end. The remainder of the aboral surface is grooved—this groove expanding posteriorly to form an escutcheon beneath the cusp. The inner (unfigured) side of the oral surface of the bar is laterally extended to form a narrow platform which is slightly nodose but not denticulate.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3367.

BRYANTODUS sp. C
Plate 24, figure 23

The bar is strongly bowed and up-arched. Aborally, both extremities of the bar are keeled but progressively toward the mid-length these keels diminish. Beneath the cusp, the bar is essentially flat. A median lateral ridge is present on the anterior bar limb; this ridge migrates progressively orad posteriorly on the bar. The inner oral surface of the bar is laterally extended in the form of a small platform or "shelf" which bears no ornamentation. Nine laterally compressed, partially confluent denticles are present on the anterior bar limb and six such denticles appear on the posterior bar extension. This form seems closely related to *B. iowaensis* (Pl. 24, fig. 18). However, the lack of a prominent node on either the inner or outer aboral margins of the bar below the cusp and the pronounced outward bowing of the bar are two distinct differences.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3368.

BRYANTODUS? sp.
Plate 25, figure 24

The bar is moderately bowed as well as arched. The denticles are confluent, laterally compressed, and number about nine on the anterior bar limb. The cusp is not much larger than the denticles and is produced aborally as a small process on the outer margin of the bar. Aborally, the bar in the region beneath the cusp is excavated.

The generic affinities of this form are uncertain. It is described because of the interesting inclusions of what appears to be pyrite or chalcopyrite in the bar near and along the cusp. When the specimen is moistened with oil or water these small irregular iridescent masses are readily apparent. They are the only occurrence of this type in conodonts that has come to the writer's attention.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3369.

CTENOGNATHUS FALSIFORMIS Stauffer
Plate 25, figure 3

Ctenognathus falsiformis STAUFFER, 1938, Jour. Paleontology, vol. 12, pp. 412, 425, pl. 48, figs. 4, 7.

This blade-like form has about 13 denticles anterior, and about 11 posterior to the cusp. The denticles are closely fused and laterally compressed except in the near vicinity of their apices where they become discrete and are somewhat rounded. Posterior to the cusp, the denticles are more deeply inserted and shorter than are the anterior denticles. Aborally, a slight escutcheon is present beneath the cusp but the remainder of the blade is sharply keeled. The illustrated specimen also resembles *C. falcatus* Stauffer but does not appear to possess as recumbent a cusp and denticles. Other forms which appear to be related to this species are *Nothognathella? abnormis* Branson and Mehl, from the Grassy Creek shale, and the specimen originally described from the Genesee of New York as *Prioniodus colligatus* Bryant and illustrated by his figure 8 on plate 6. The genus

Ctenognathus was set aside by Ulrich and Bassler (1926, p. 54) as being insufficiently established. It is here recognized, however, with acknowledgment that it would be restudied when sufficient material can be assembled.

Occurrence.—Olentangy shale of Ohio and an Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Hypotype.—State Univ. Iowa, 3370.

EUPRIONIODINA sp. A
Plate 25, figure 2

The cusp is stout, laterally compressed, sharp on its anterior and posterior edges, and somewhat recurved. The denticles on the bar are closely set, stout, and laterally compressed. The anticusp (incomplete on figured specimen) is deflected inward and downward. Aborally, the bar is keeled; on its outer lateral surface there is a median ridge. This form is somewhat similar to *E. obtusidens* Youngquist described from an Upper Devonian shale near Middle Amana, Iowa.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3371.

EUPRIONIODINA sp. B
Plate 26, figure 10

The posterior bar extension and the cusp are preserved on the figured individual. The proximal end of the incomplete anticusp indicates that it was sharply deflected downward. The cusp is long, slender, rounded, and slightly recurved near its tip. The posterior bar bears four rounded subequal denticles. Aborally, the bar is sharply keeled at and near its distal end but this keel progressively gives way to a slight excavation of the bar in the area beneath the cusp.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3372.

EUPRIONIODINA? aff. E.? sp. Stauffer
Plate 26, figure 8

The oral surface of the bar is entirely occupied by denticles which are subequal in size and slightly inclined posteriorly. These denticles are somewhat compressed laterally, oval in cross section, and possess sharpened anterior and posterior margins. The bar is not bowed, the denticles are not inclined laterally and there is consequently no certainty as to which is the outer side. The bar proper bears a median lateral ridge. The aboral surface of the bar is moderately keeled anteriorly and slightly grooved posteriorly. This form somewhat resembles that illustrated by Stauffer (1938, p. 426, pl. 52, fig. 7 [not fig. 2]) from the Olentangy shale.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3373.

EUPRIONIODINA? sp.
Plate 26, figure 19

This fragmental specimen has a strongly produced cusp which is roughly oval in cross section and is slightly sharpened on the anterior and posterior edges. The anticusp is incomplete but appears to have been short and recurved inward as well as downward. Aborally, the bar is slightly grooved and it is excavated beneath the cusp. All the preserved denticles are much compressed laterally.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3374.

HIBBARDELLA ANGULATA (Hinde)
Plate 24, figures 16, 17, plate 25, figure 7

Prioniodus angulatus HINDE, 1879, Geol. Soc. London Quart. Jour., vol. 35, p. 360, pl. 15, fig. 17.

Prioniodus angulatus GRABAU, 1899, Buffalo Soc. Nat. Sci. Bull., vol. 6, p. 151, fig. 33D.

Prioniodus angulatus GRABAU and SHIMER, 1910, North Am. Index fossils, invertebrates, vol. 2, pp. 244, 245, fig. 1537h.

Prioniodus angulatus BRYANT, 1921, Buffalo Soc. Nat. Sci. Bull., vol. 13, p. 17.

Hibbardella angulata ULRICH and BASSLER, 1926, U. S. Nat. Mus. Proc., vol. 68, art. 12, pp. 16, 17, 37, pl. 3, figs. 1–4.

Hibbardella angulata HOLMES, 1928, U. S. Nat. Mus. Proc., vol. 72, art. 5, p. 11, pl. 5, fig. 31.

Hibbardella angulata BRANSON and MEHL, 1933, Missouri Univ. Studies, vol. 8, no. 2, pp. 141–142, pl. 11, fig. 16.

Hibbardella angulata HUDDLE, 1934, Bull. Am. Paleontology, vol. 21, no. 72, pp. 16, 21, 22, 78–79, pl. 3, figs. 6, 7; pl. 10, fig. 12.

Hibbardella angulata BRANSON and MEHL, 1944, *in* SHIMER and SHROCK, Index fossils of North America, p. 241, pl. 93, fig. 73.

This species is abundantly represented in

the collection at hand. Slight variations are evident but the characteristic features are the somewhat laterally compressed, sharp-edged cusp, the small discrete denticles, and the two bar limbs which are approximately rectangular in cross section.

Occurrence.—Genesee beds and Rhinestreet shale of New York, the "Cleveland Shales" (Hinde, 1879) of Ohio, the New Albany shale of Indiana and an Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Hypotypes.—State Univ. Iowa, 3375 (pl. 24, fig. 16), 3376 (pl. 24, fig. 17), 3377 (pl. 25, fig. 7) and 3378 (unfigured specimens).

HIBBARDELLA HAWKEYENSA Youngquist, n. sp.
Plate 25, figure 20

The bar limbs are compressed laterally, sharply keeled aborally, and joined at the point of cusp insertion to form an angle of very nearly 90 degrees. The majority of the denticles are long and slender, circular in cross section, and deeply "inserted" into the bar. A short denticle is present on the extremities of each bar limb. A small denticulate bar joins the main bar at the base of the cusp and extends directly inward. The cusp is rounded on the inner (unfigured) surface but is somewhat flattened on the outer side.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Holotype.—State Univ. Iowa, 3379.

HIBBARDELLA SUBAEQUALIS Ulrich and Bassler
Plate 26, figure 14

Hibbardella subequalis ULRICH and BASSLER, 1926, U. S. Nat. Mus. Proc., vol. 68, art. 12, p. 38, pl. 3, figs. 6, 7.
Hibbardella subaequalis Holmes, 1928, U. S. Nat. Mus. Proc., vol. 72, art. 5, p. 11.

The cusp is tapered, laterally compressd and in long axis slightly curved in its apical half. The bar is also laterally compressed, strongly up-arched, and possesses an aboral keel. The denticles of the figured specimen are incompletely preserved but apparently are irregular in size. The inward extension of the bar which is normal to the main arched bar and joins it at the base of the cusp is present but not well developed and bears no denticles.

Occurrence.—Rhinestreet shale of New York and an Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Hypotype.—State Univ. Iowa, 3380.

HIBBARDELLA sp.
Plate 25, figure 6

The illustrated specimen, though fragmentary, is clearly referable to the genus *Hibbardella*. One entire bar limb and much of the cusp is preserved and these indicate that this species had denticles unusually large relative to the cusp. Also, the bar is somewhat compressed laterally and becomes sharpened aborally to form a keel. The denticles and the cusp are rounded, and the latter has a small median longitudinal groove on its inner side. Though one bar limb as well as the inward extension of the bar are only partially preserved, this form appears to be closely related to the type species of the genus, *H. angulata* (Hinde) which has been well illustrated and described by Ulrich and Bassler from the Rhinestreet shale of New York.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3381.

HINDEODELLA? TRIRADIATA Youngquist, n. sp.
Plate 26, figure 3

This single well preserved specimen has a laterally compressed posterior bar which bears an alternating series of one or two small erupted or germ denticles between each two adjacent larger denticles. The large denticles are laterally compressed; the small denticles are rounded. The posterior bar extension terminates anteriorly in a stout cusp. Forward of the cusp, an anticusp is present which curves sharply inward and downward. The anticusp also bears both large and small denticles. At the base of the cusp and on the outer side, a third bar limb is present extending directly outward. The presence of this third bar limb, which also is denticulate, sets off this specimen from all other known hindeodellids. Aborally, the entire specimen is keeled and no escutcheon or excavation is apparent beneath the cusp.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Holotype.—State Univ. Iowa, 3382.

HINDEODELLA sp. A
Plate 24, figure 20

Fragmentary representatives of the genus *Hindeodella* are common in the collection at hand. The illustrated specimen is incomplete, but presumably preserves much of the posterior portion of the bar. The denticles are not deeply "inserted" in the bar and they consist of an alternating series wherein two or three small denticles are intercalated between larger denticles. The bar is rounded, gently up-arched and slightly bowed, and terminates posteriorly in the form of a small orally crenulated "blade." This specimen is a generalized type of *Hindeodella* which occurs widely. Among others it compares closely with *H. priscilla* and *H. milleri*, both of Stauffer, described from the Olentangy shale.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3383.

HINDEODELLA sp. B
Plate 25, figure 4

This species is a simple form of *Hindeodella* consisting of an alternation of large denticles with one or two small denticles. Unlike most hindeodellids, however, the denticles of this individual are neither crowded nor deeply "inserted." The bar is subrectangular in cross section, being rounded laterally. It is essentially straight or only slightly up-arched. The particular specimen described as *Polygnathus dubius* and figured by Hinde (1879, p. 362, pl. 16, fig. 12) from the Genesee of New York and adjacent areas, and Clarke's specimen (1887, p. 31, pl. A1, fig. 19) from the Naples of New York are very similar to the individual here described.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3384.

HINDEODELLA sp. C
Plate 25, figure 9

The long, large, somewhat laterally compressed denticles alternate with one or two small rounded denticles. The denticles of this form are not "inserted" but rather appear to grade into the bar material. The lower fourth of both the inner and outer surfaces of the bar taper inward to form a small but sharp aboral keel. All denticles incline posteriorly at a slight angle but do not curve appreciably inward.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3385.

ICRIODUS LATERICRESCENS Branson and Mehl
Plate 25, figure 12

Icriodus latericrescens BRANSON and MEHL, 1938, Jour. Paleontology, vol. 12, pp. 156, 158, 164–165, pl. 26, figs. 30–37.

Icriodus latericrescens STAUFFER, 1938, Jour. Paleontology, vol. 12, pp. 413, 430, pl. 52, figs. 30–32, 34.

Icriodus latericrescens GROHSKOPF, CLARK, and ELLISON, 1943, Missouri Geol. Survey and Water Res. 62nd Bienn. Rept. Appendix 4, p. 16, pl. 2, figs. 4, 7.

Icriodus latericrescens BRANSON and MEHL, 1944, *in* SHIMER and SHROCK, Index fossils of North America, p. 245, pl. 94, fig. 64.

Icriodus latericrescens BRANSON and MEHL, 1944, *in* BRANSON, Missouri Univ. Studies, vol. 19, no. 3, p. 134.

Icriodus latericrescens CLARK, 1944, *in* BRANSON, Missouri Univ. Studies, vol. 19, no. 3, p. 155.

The figured specimen appears to be complete in every respect. It preserves seven denticles in each of the lateral rows. Midway between these is a narrow, slightly sinuous ridge, not so high as the denticles, terminating posteriorly in a small node. The postero-lateral expansion of the platform has three large denticles which are arranged in arcuate form, being convex anteriorly. Aborally the specimen is broadly and rather deeply grooved. This excavation is narrower than the platform at and near the anterior end, but midway posteriorly the aboral margins of the platform flare markedly and continue to be visible in oral view to the posterior end of the specimen.

Both the generic and specific affinities of these specimens seem certain, especially in view of the statement by Branson and Mehl (1938, p. 165) that this is "one of the most variable" of the icriodid species. *I. latericrescens* appears to be widely represented in Middle Devonian strata. However, the occurrence of this form in the collection under consideration together with the occurrence recorded by Stauffer from the Olentangy shale may extend the range of this species into the Upper Devonian.

Occurrence.—Mineola limestone and the Fortune formation of Missouri, the Jeffersonville limestone of Indiana, the Ferron Point formation of Michigan, the Silica and Olentangy shales of Ohio, and possibly the Genundewa limestone of New York. Occurs also in an Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Hypotypes.—State Univ. Iowa, 3386 (fig. 12) and 3387 (unfigured specimen).

Icriodus subterminus Youngquist n. sp.
Plate 25, figure 14

This is a particularly short, stout species with an aboral margin that is broadly flared. The denticles in each lateral row number about four, and are rather widely separated. There are about seven denticles in the median row; except for the denticles which are at each extremity of the median row, these are lower than those of the two lateral rows. The terminal denticles of the median row are very large and form the anterior and posterior ends of the specimen. The denticles of the lateral rows are somewhat uniformly spaced, those in the median row are irregular. Aborally, the specimen is narrowly grooved at the extreme end but the aboral margins of the excavation flare very near to the anterior end and encompass a broad deep excavation which, however, is reduced again to a narrow groove near and at the posterior end of the specimen.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Holotype.—State Univ. Iowa, 3388.

Icriodus symmetricus Branson and Mehl
Plate 25, figure 5

Icriodus symmetricus Branson and Mehl, 1934 [1933], Missouri Univ. Studies, vol. 8, no. 3, p. 226, pl. 13, figs. 1–3.
Irciodus symmetricus Branson and Mehl, 1938, Jour. Paleontology, vol. 12, pp. 156, 158, 161, pl. 26, figs. 1–3.
Icriodus symmetricus Branson and Mehl, 1944, *in* Shimer and Shrock, Index fossils of North America, pp. 245–246, pl. 94, fig. 65.
Icriodus symmetricus Branson and Mehl, 1944, *in* Branson, Missouri Univ. Studies, vol. 19, no. 3, p. 163, pl. 28, figs. 1–3.
Icriodus symmetricus Branson, 1944, Missouri Univ. Studies, vol. 19, no. 3, p. 173.

Two well preserved specimens in the collection at hand seem clearly referable to the species first described by Branson and Mehl from the Grassy Creek shale of Missouri. The figured specimen has ten denticles in the median row and seven in each lateral row. The posterior two denticles in the median row are considerably larger than the others. The anterior two-thirds of the aboral excavation is narrow, being well within the lateral limits of the platform. The posterior third of the excavation is broadly flared into a subcircular form and it extends about equally far on each side of the specimen. The unfigured specimen is somewhat more narrow in platform outline than the form illustrated.

Occurrence.—Grassy Creek shale and Louisiana limestone of Missouri, the Sylamore sandstone of Arkansas, and an Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Hypotypes.—State Univ. Iowa, 3389 (figured specimen) and 3390 (unfigured specimen).

Ligonodina cf. L. acuta Branson and Mehl
Plate 24, figures 13, 19

Ligonodina acuta Branson and Mehl, 1934 [1933], Missouri Univ. Studies, vol. 8, no. 3, p. 200, pl. 15, fig. 32.
Ligonodina acuta Branson and Mehl, 1944, *in* Branson, Missouri Univ. Studies, vol. 19, no. 3, p. 163.

The cusp is exceedingly long and stout and it is somewhat flattened on the inner side as shown by the specimen illustrated by figure 13, but is rounded on the outer side—see specimen illustrated by figure 19. The anterior-inferior (anticusp) extension of the bar is pointed and curved sharply downward near its distal end and it bears three stout denticles which are slightly compressed laterally. The aboral surface of this process is sharply keeled. The posterior bar limb is rectangular in cross section and its denticles are slender and rounded. Aborally, these specimens are moderately excavated in the angle between the bar and the anticusp.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa, and possibly in the Grassy Creek shale of Missouri.

Repository.—State Univ. Iowa, 3391 (fig.

13), 3392 (fig. 19) and 3393 (unfigured specimens).

LIGONODINA BICINCTA Huddle
Plate 25, figures 10, 18

Ligonodina bicincta HUDDLE, 1934, Bull. Am. Paleontology, vol. 21, no. 72, pp. 15, 62, pl. 12, fig. 15.

There are many representatives of this species in the collection at hand. Although all of them are fragmentary to some extent, they preserve the general characteristics of a rounded long recurved cusp, a moderately slender and slightly up-arched bar, small needle-like denticles, a short denticulate anticusp, which is sharply deflected aborally, and a small excavation on the inferior surface of the bar directly beneath the cusp.

Occurrence.—New Albany shale of Indiana and an Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Hypotypes.—State Univ. Iowa, 3394 (fig. 10), 3395 (fig. 18), and 3396 (unfigured specimens).

LIGONODINA MAGNIDENS Ulrich and Bassler?
Plate 26, figure 17

? *Ligonodina magnidens* ULRICH and BASSLER, 1926, U. S. Nat. Mus. Proc., vol. 68, art. 12, p. 14, pl. 2, figs. 5, 6.

? *Ligonodina magnidens* HOLMES, 1928, U. S. Nat. Mus. Proc., vol. 72, art. 5, p. 12.

The unusually large denticles characteristic of Ulrich and Bassler's syntypes are also present on the specimen from the shale occurring near North Liberty, Iowa, and, although this latter individual is incomplete, it appears to be very close to the forms originally described from the Rhinestreet shale of New York. The anticusp of the specimen under consideration is abruptly curved inward and aborally, and it possesses three denticles. The cusp is recurved posteriorly but not inward and it is essentially circular in cross section as are the denticles. The denticles are large and at least one is as large if not larger than the cusp. Aborally, the bar is slightly grooved and beneath the region of the cusp it is shallowly excavated.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa and possibly the Rhinestreet shale, Shaleton, New York.

Repository.—State Univ. Iowa, 3397.

LIGONODINA? sp. A
Plate 24, figures 15, 22

Several incomplete specimens in the collection at hand have the general characters of those illustrated. The denticles are circu-

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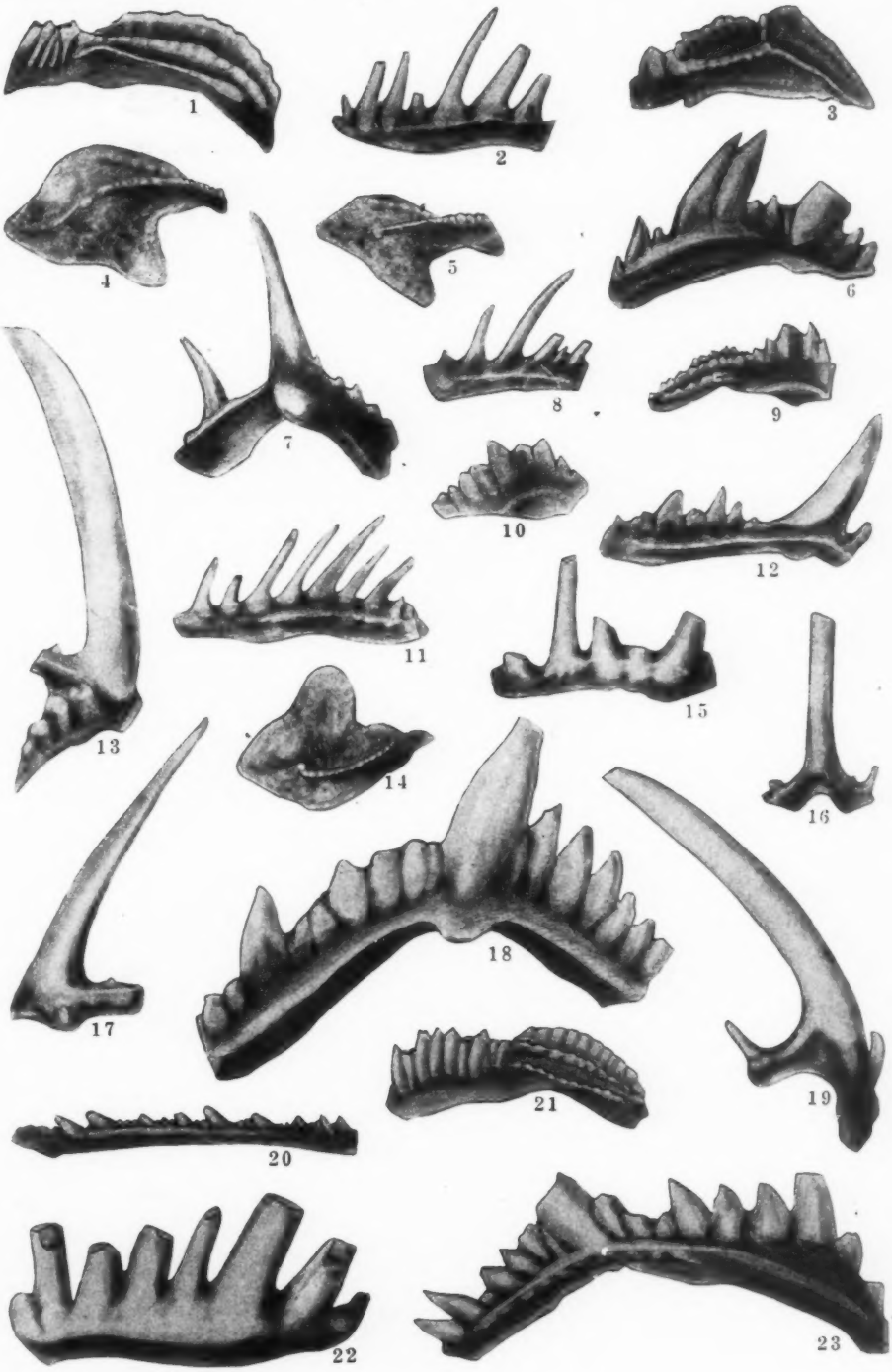
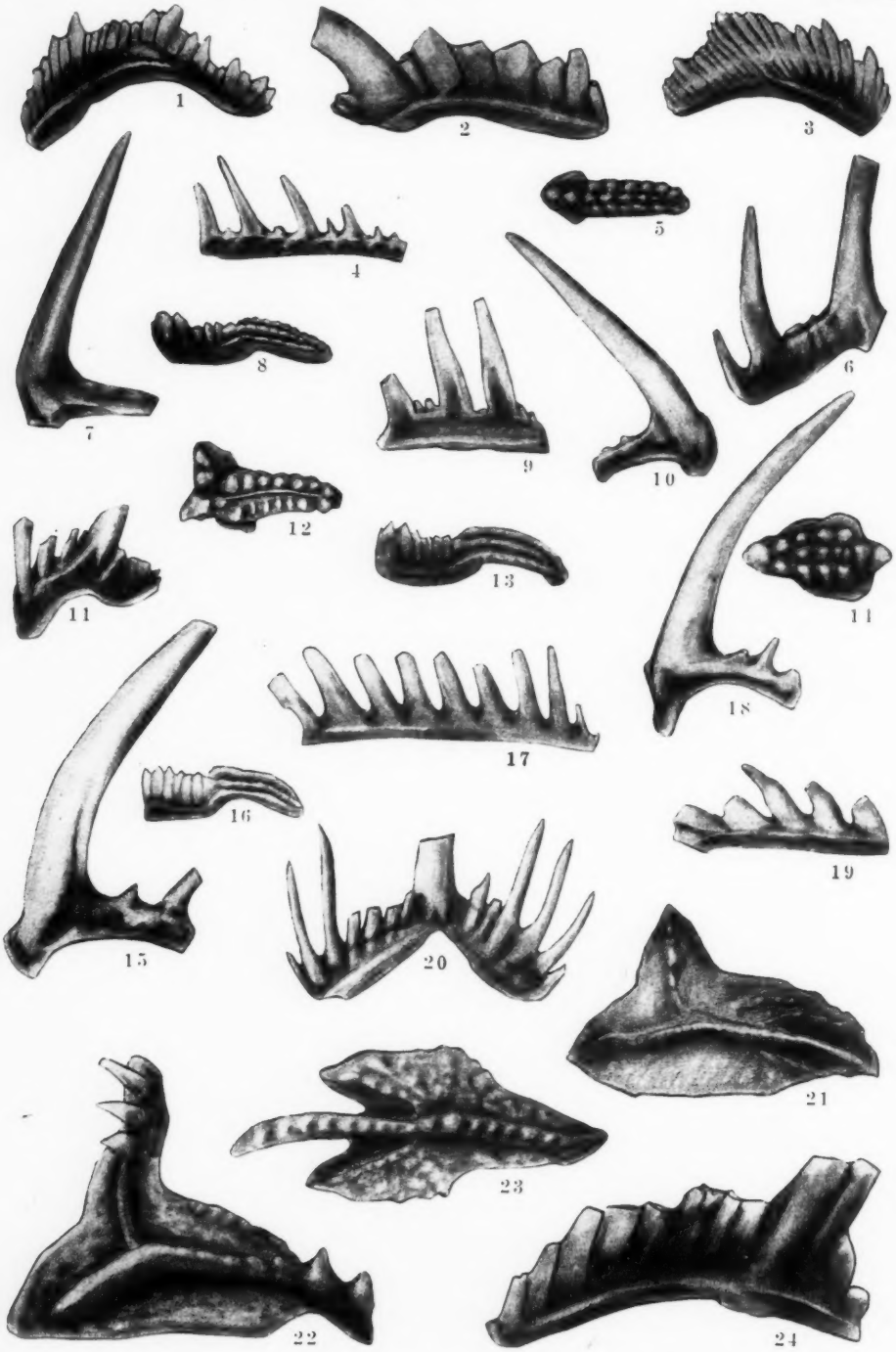
EXPLANATION OF PLATE 24

All specimens are from an Upper Devonian shale exposed in the NW ¼ sec. 8, T. 80 N., R. 6 W., Johnson County, Iowa. The illustrations are ×30.

FIGS. *1*—*Polygnathus percarinata* Youngquist, n. sp. (p. 109)
2—*Lonchodus?* sp. See also figs. 8, 11. (p. 107)
3—*Ancyrognathus cava* Youngquist, n. sp. (p. 97)
4—*Palmatolepis marginata* Stauffer. See also fig. 14. (p. 108)
5—*Palmatolepis* sp. (p. 108)
6—*Bryantodus* sp. A (p. 98)
7—*Lonchodina?* sp. (p. 107)
8—*Lonchodus?* sp. See also figs. 2, 11. (p. 107)
9—*Polygnathus spinulosa* Youngquist, n. sp. (p. 110)
10—*Polygnathus* sp. (p. 110)
11—*Lonchodus?* sp. See also figs. 2, 8. (p. 107)
12—*Bryantodus* sp. B. (p. 99)
13—*Ligonodina* cf. *L. acuta* Branson and Mehl. See also fig. 19. (p. 103)
14—*Palmatolepis marginata* Stauffer. See also fig. 4. (p. 108)
15—*Ligonodina* sp. A. See also fig. 22. (p. 104)
16—*Hibbardella angulata* (Hinde). See also fig. 17, and pl. 25, fig. 7. (p. 100)
17—*Hibbardella angulata* (Hinde). See also fig. 16, and pl. 25, fig. 7. (p. 100)
18—*Bryantodus iowaensis* Youngquist, n. sp. (p. 98)
19—*Ligonodina* cf. *L. acuta* Branson and Mehl. See also fig. 13. (p. 103)
20—*Hindeodella* sp. A. (p. 102)
21—*Polygnatha decorosa* Stauffer (p. 109)
22—*Ligonodina?* sp. A. See also fig. 15. (p. 104)
23—*Bryantodus* sp. C. (p. 99)



Youngquist, Upper Devonian Conodonts



Youngquist, Upper Devonian Conodonts

lar in cross section, discrete and subequal in size. The cusp is slightly larger than the largest denticle and it too is rounded. The bar limbs are nearly normal to one another and one is slightly deflected downward. Aborally the bar is flat near its extremities but toward the point of cusp insertion it flares laterally on the inner side and becomes very broadly excavated. Despite the size discrepancy, the figured specimens are very similar in detail and appear to be representatives of the same species. Both may possibly belong in *Lonchodina*.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 3398 (fig. 15), 3399 (fig. 22) and 4025 (unfigured specimens).

LIGONODINA sp. B
Plate 25, figure 15

The illustrated specimen is fragmentary but preserves most of the cusp and part of the bar as well as the proximal portion of the anticusp. The cusp is exceptionally prominent, subrectangular in cross section and in transmitted light it shows a distinct growth axis appearing as a linear series of small inverted "cones" which are assumed to be light-reflecting growth surfaces. A conspecific unfigured specimen likewise exhibits a distinct growth axis—a feature usually not prominent in Devonian conodonts.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa

Repository.—State Univ. Iowa, 4026 (figured specimen) and 4027 (unfigured specimen).

LIGONODINA sp. C
Plate 26, figure 15

This fragmentary specimen is unusual in that the anterior bar extension is normal to the posterior bar and furthermore, if the denticles and the cusp are assumed to be inclined inward, the anterior bar extends directly outward. The posterior bar bears four stub-like denticles, and it is keeled aborally. The anterior bar is incomplete but preserves two short denticles; a keel is not present. Only a slight excavation is evident beneath the cusp.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 4028.

LIGONODINA? sp.
Plate 26, figure 18

The cusp is long, stout, rounded, and curves slightly inward near the apex. The

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EXPLANATION OF PLATE 25

All specimens are from an Upper Devonian shale exposed in the NW. ¼ sec. 8, T. 80 N., R. 6 W., Johnson County, Iowa. The illustrations are ×30.

FIGS. *1*—*Nothognathella brevidonta* Youngquist, n. sp. (p. 108)
2—*Euprioniodina* sp. A. (p. 100)
3—*Ctenognathus falsiformis* Stauffer. (p. 99)
4—*Hindeodella* sp. B. (p. 102)
5—*Icriodus symmetricus* Branson and Mehl. (p. 103)
6—*Hibbardella* sp. (p. 101)
7—*Hibbardella angulata* (Hinde). See also pl. 24, figs. 16, 17. (p. 100)
8—*Polygnathus parviuscula* Youngquist, n. sp. See also figs. 13, 16. (p. 109)
9—*Hindeodella* sp. C. (p. 102)
10—*Ligonodina bicincta* Huddle. See also fig. 18. (p. 104)
11—*Lonchodina* sp. (p. 106)
12—*Icriodus latericrescens* Branson and Mehl (p. 102)
13—*Polygnathus parviuscula* Youngquist, n. sp. See also figs. 8, 16. (p. 109)
14—*Icriodus subterminus* Youngquist, n. sp. (p. 103)
15—*Ligonodina* sp. B. (p. 105)
16—*Polygnathus parviuscula* Youngquist, n. sp. See also figs. 8, 13. (p. 109)
17—*Lonchodus?* sp. (p. 107)
18—*Ligonodina bicincta* Huddle. See also fig. 10. (p. 104)
19—*Lonchodus? constrictiterminatus* Youngquist, n. sp. (p. 107)
20—*Hibbardella hawkeyensa* Youngquist, n. sp. (p. 101)
21—*Ancyrognathus irregularis* Branson and Mehl. (p. 97)
22—*Ancyrognathus iowaensis* Youngquist, n. sp. (p. 97)
23—*Ancyrodella gigas* Youngquist, n. sp. (p. 96)
24—*Bryantodus?* sp. (p. 99)

denticles of the bar are also relatively large and the denticles as well as the cusp are inclined posteriorly. Aborally, the bar is for the most part flat, but it becomes broadly excavated beneath the cusp. The anterior bar extension is missing as well as a portion of the posterior bar on the illustrated specimen.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 4029.

LONCHODINA CLAVATA (Hinde)
Plate 26, figure 12

Prioniodus clavatus HINDE, 1879, Geol. Soc. London Quart. Jour., vol. 35, p. 360, pl. 15, fig. 16.
Prioniodus clavatus GRABAU, 1899, Buffalo Soc. Nat. Sci. Bull., vol. 6, p. 151, fig. 33c.
Prioniodus clavatus GRABAU and SHIMER, 1910, North Am. index fossils, invertebrates, vol. 2, pp. 244, 245, fig. 1537b.
Prioniodus clavatus BRYANT, 1921, Buffalo Soc. Nat. Sci. Bull., vol. 13, p. 16, pl. 6, figs. 3, 6.
Lonchodina clavata HOLMES, 1928, U. S. Nat. Mus. Proc., vol. 72, art. 5, pp. 13, 20, pl. 5, fig. 9.
Lonchodina clavata BRANSON and MEHL, 1933, Missouri Univ. Studies, vol. 8, no. 2, pp. 137–138, pl. 11, figs. 30, 31.

This species is represented by a single well preserved individual in the collection at hand. It is moderately bowed outward and somewhat up-arched. The bar limbs are subequal in size and each preserves portions of five denticles. The denticles and the cusp are essentially circular in cross section. Though the cusp and the denticles are all fractured, it particularly resembles the specimen described by Bryant from the Genesee beds in Erie County, New York.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa and the Genesee beds of New York.

Hypotype.—State Univ. Iowa, 4030.

LONCHODINA aff. L.? INCREBESCENS
Ulrich and Bassler
Plate 26, figure 13

This incomplete individual apparently preserves only the anticusp or anterior extension of the bar together with the cusp. The denticles as well as the cusp are compressed laterally and all are inclined in a direction assumed to be posterior. The posterior bar extension is almost entirely missing but its point of attachment (not visible from side illustrated) indicates that it formed an acute angle with the anticusp. Probably this individual is close to the specimen described as *L.? increbescens* by Ulrich and Bassler (1926, p. 35, pl. 5, fig. 20) from the Rhinestreet shale of New York.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 4031.

LONCHODINA aff. L. PULCHRA
Branson and Mehl
Plate 26, figur 9

The figured specimen preserves six denticles which are essentially circular in cross section and inclined in a direction assumed to be posterior. The bar is moderately bowed outward and on both the inner and outer surfaces it bears a slight lateral ridge which is located somewhat orad of median. Aborally the bar is keeled. This form seems referable to the genus *Lonchodina* and probably represents a portion of the bar of a specimen related to *L. pulchra* illustrated by Branson and Mehl (1934 [1933], pl. 15, fig. 16) from the Grassy Creek shale of Missouri.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 4032 (figured specimen) and 4033 (unfigured specimen).

LONCHODINA sp.
Plate 25, figure 11

This fragmental specimen is strongly up-arched and moderately bowed. The denticles are irregularly spaced; they are not uniform or progressively gradational in size, but all are deeply "inserted." At least one denticle is somewhat wider near its apex than at its point of insertion in the bar. The cusp is asymmetrically inserted at approximately the crest of the arched bar. Aborally, the bar is sharply keeled. The inner (unfigured) side of the specimen does not differ appreciably from the side shown by the outer view.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 4034.

LONCHODINA? sp.
Plate 24, figure 7

The affinities of this specimen are uncertain. It consists of two keeled bars which join at the cusp at an acute angle and bear small nodes on one limb and at least one rounded denticle on the other. The cusp tapers uniformly from base to tip, is rounded on one side, flattened on the other, and slightly excavated aborally. On the basis of the inclination of the denticles, the inner side of the specimen is presumably illustrated.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 4035.

LONCHODUS? CONSTRICTITERMINATUS
Youngquist, n. sp.
Plate 25, figure 19

This species is particularly characterized by the abrupt termination of the relatively stout denticles and by their lack of uniform taper from base to apex. Slightly orad of midlength, the stout denticles are distinctly constricted and achieve their apices in a distance that is considerably less that it would be if the taper begun at the base were continued. In cross section the denticles are oval, being slightly sharpened on their anterior and posterior margins. The denticles incline backward at an angle that progressively increases posteriorly. The bar is flat aborally except for the presence of a narrow longitudinal median groove. The sides of the bar are essentially straight and the oral bar surface is rounded.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Holotype.—State Univ. Iowa, 4036.

LONCHODUS? sp.
Plate 24, figures 2, 8, 11

The bar is laterally compressed, sinuous, and slightly keeled aborally. A lateral longitudinal ridge-like thickening of the bar is evident somewhat orad of median. The denticles are needle-like, being circular in cross section and slender. In general, the denticles curve markedly inward at and near their apices but due to extreme sinuosity of the bar in two planes (see fig. 3) some of the denticles tend to point outward. Occasional germ or small erupted denticles are present in the bar. These specimens, though incomplete on one or both ends, appear to represent a single species. The form termed *Polygnathus dubius* described by Hinde (1879) and illustrated by figure 11 on his plate 16, appears to be close to these Upper Devonian forms from the shale near North Liberty.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 4037 (fig. 2), 4038 (fig. 8), and 4039 (fig. 11).

LONCHODUS? spp.
Plate 25, figure 17, plate 26, figures 2, 16

These specimens are exceptionally long denticulated bars which are nevertheless somewhat fragmental and probably represent portions of several generic forms. They are tentatively placed in *Lonchodus* for they have the simple characters of the specimens which are usually included in that very broadly applied genus.

The individual illustrated by figure 17 on plate 25 has a nearly uniform row of denticles which are circular in cross section and all incline inward and backward. The bar is slightly bowed and arched and it bears a small aboral ridge. This specimen is complete anteriorly and in many ways closely resembles the form described as *Polygnathus princeps* by Hinde (1879, p. 365, pl. 16, fig. 23) from the Genesee of New York. Figure 2 on plate 26 has the characteristics of the form described above except that the denticles are more slender. The specimen illustrated by figure 16 on plate 26 is unusual in that the anterior denticles curve inward, the denticles about midway on the bar are not inclined laterally, and the posterior four or five denticles are curved slightly outward. The bar is not bowed, but is slightly arched. It is essentially rectangular in cross section and has a small longitudinal aboral groove.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 4040 (pl. 25, fig. 17), 4041 (p. 26, fig. 2), and 4042 (pl. 26, fig. 16).

NOTHOGNATHELLA BREVIDONTA
Youngquist n. sp.
Plate 25, figure 1

This species is characterized by a pronouncedly up-arched and bowed bar surmounted by relatively short, stout denticles. All the denticles are fused nearly to their apices and laterally compressed, and those in the anterior portion of the bar are larger than those of the posterior limb. The lateral platform-extension of the bar is most prominent midlength on the specimen but extends in a subdued ridge-like manner both anteriorly and posteriorly the entire length of this form. The platform is approximately the same size on the inner (unfigured) side as on the outer side. Aborally, the specimen is sharply keeled, particularly on the anterior third of the bar. From both extremities, this keel is progressively reduced in size toward the midpoint on the bar but is present the entire bar length—there being no aboral excavation or escutcheon.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Holotype.—State Univ. Iowa, 4043.

PALMATOLEPIS MARGINATA Stauffer
Plate 24, figures 4, 14

Palmatolepis marginatus STAUFFER, 1938, Jour. Paleontology, vol. 12, pp. 413, 437, pl. 53, figs. 3, 7, 8, 13, 17.

These are thin, warped and arched plates, with a small blade which lies almost entirely within the plate margin and extends posteriorly as a low carina. The lobes of the plate are rounded in outline with a slight crenulate edge. Oral ornamentation consists of very small nodes. A slight keel is present aborally, extending nearly the full length of the plate directly beneath the position of the carina and blade. The escutcheon beneath the azygous node is very small. This species seems to have several closely related forms in *Palmatolepis subperlobata* and *P. perlobata* from the Grassy Creek shale.

Occurrence.—Olentangy shale of Ohio and Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Hypotypes.—State Univ. Iowa, 4044 (fig. 4), 4045 (fig. 14), and 4046 (unfigured specimens).

PALMATOLEPIS sp.
Plate 24, figure 5

The plate is small, thin, slightly and irregularly concave on its oral surface, and subangular in outline. The lateral lobe of the plate extends obliquely anterior. The blade is essentially straight as is the carina. A small azygous node is central on the plate

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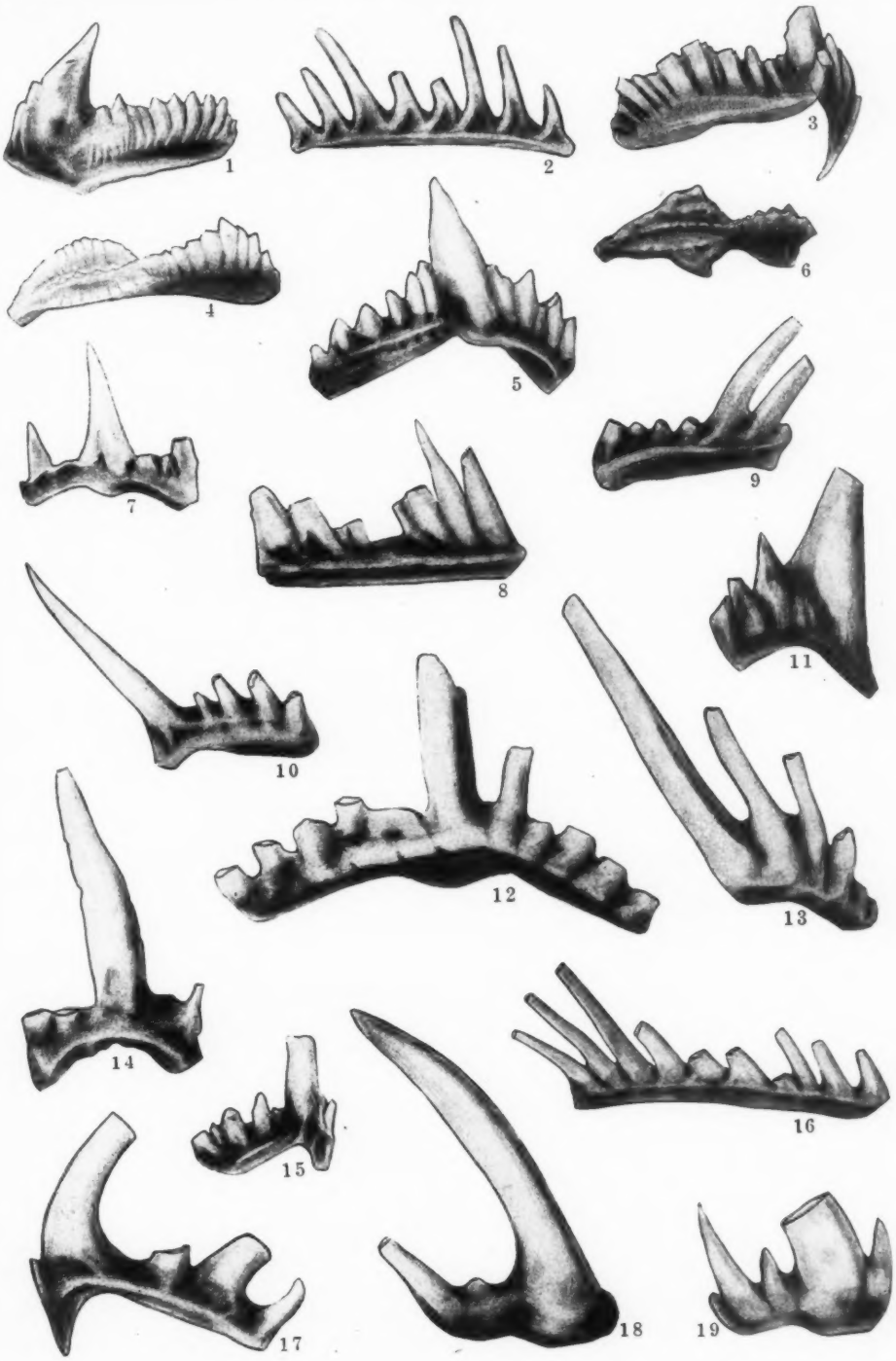
EXPLANATION OF PLATE 26

All specimens are from an Upper Devonian shale exposed in the NW. ¼ sec. 8, T. 80 N., R. 6 W., Johnson County, Iowa. The illustrations are ×30.

FIGS. *1*—*Spathognathodus gratiosus* (Stauffer). (p. 111)
2—*Lonchodus?* sp. (p. 101)
3—*Hindeodella? triradiata* Youngquist, n. sp. (p. 101)
4—*Polygnathus spatulata* Youngquist, n. sp. (p. 110)
5—*Bryantodus machaerodus* Youngquist, n. sp. (p. 98)
6—*Polygnathus rotundiloba* Bryant. (p. 110)
7—*Prioniodina* sp. (p. 111)
8—*Euprioniodina?* aff. *E.?* sp. Stauffer. (p. 100)
9—*Lonchodina* aff. *L. pulchra* Branson and Mehl. (p. 106)
10—*Euprioniodina* sp. B. (p. 100)
11—*Prioniodus alatus* Hinde. (p. 111)
12—*Lonchodina clavata* (Hinde). (p. 106)
13—*Lonchodina* aff. *L.? increbscens* Ulrich and Bassler. (p. 106)
14—*Hibbardella subaequalis* Ulrich and Bassler. (p. 101)
15—*Ligonodina* sp. C. (p. 105)
16—*Lonchodus?* sp. (p. 107)
17—*Ligonodina magnidens* Ulrich and Bassler? (p. 104)
18—*Ligonodina?* sp. (p. 105)
19—*Euprioniodina?* sp. (p. 100)



Youngquist, Upper Devonian Conodonts

UNIV. OF MICH.

and the carina extends only slightly anterior to it. Aborally, a narrow keel extends from the anterior end of the blade to directly beneath the azygous node where it bifurcates and continues on the two posterior lobes. Only a very small flattened area indicative of an escutcheon is evident at the point of bifurcation of the keel. This specimen is close to *P. flabelliformis* Stauffer but differs in the obliquely anterior extension of the lateral lobe of the plate.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 4047.

POLYGNATHUS DECOROSA Stauffer
Plate 24, figure 21

Polygnathus decorosus STAUFFER, 1938, Jour. Paleontology, vol. 12, p. 438, pl. 53, figs. 1, 5, 6, 10, 11, 15, 16, 20, 30.

The entire specimen is slightly arched and essentially straight in long axis except for a small lateral curvature near the posterior end of the plate. The blade is well developed and consists of about 10 closely set, laterally compressed denticles which are confluent to very near their apices. A few small germ denticles or "wedges" are also found in the posterior end of the blade near and at its junction with the carina. Surface ornamentation of the plate consists of a prominent median carina together with transverse furrows which extend to the margins of the plate giving it a scalloped edge. A keel is present aborally but this is modified to embrace a shallow groove beneath the posterior portion of the blade. This groove expands to form a small escutcheon beneath the anterior end of the plate.

This specimen from the shale near North Liberty is well described by the discussion of the syntypes given by Stauffer. The occurrence of "12 or more" denticles in the blade is recorded in the original description but some of the figured syntypes have less than that number and the specimen under consideration, which possesses about 10 denticles, is considered conspecific. It should be emphasized that in all other particulars the similarity of this specimen to those described by Stauffer is extremely close, especially to the specimens illustrated by figures 5 and 6 on Stauffer's plate 53 which are from a single locality of the Olentangy shale at Deep Run, Ohio.

Occurrence.—The Olentangy shale of Ohio the Olentangy shale of Lambton County, Ontario and an Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Hypotype.—State Univ. Iowa, 4048.

POLYGNATHUS PARVIUSCULA
Youngquist n. sp.
Plate 25, figures 8, 13, 16

This is a moderately small species of *Polygnathus*. The plate and blade are of about equal length. An aboral keel extends the entire length of this form, being only slightly interrupted at the junction of the plate with the blade where a small escutcheon is present. The blade is straight but the plate is moderately up-arched and in its posterior half it is slightly curved inward. The denticles of the blade number about six or seven and are subuniform in size, slightly larger ones being found anteriorly. All the denticles retain their individuality well into the plate. The lower plate margin at the base of the denticles is somewhat thickened to form a small "shoulder" or ridge. The oral carina merges anteriorly with the blade and in an essentially median position it extends to near the posterior end of the plate. The figured syntypes are complete and are illustrated from the inner side.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Syntypes.—State Univ. Iowa, 4049 (fig. 8), 4050 (fig. 13), 4051 (fig. 16) and 4110 (unfigured syntype).

POLYGNATHUS PERCARINATA
Plate 24, figure 1

The plate is moderately arched, gently bowed, and decidedly concave on its oral surface. The aboral surface bears a sharp keel the entire length of the plate and blade except for the interruption of a very small escutcheon slightly posterior of the junction of the blade with the plate. A large carina extends the length of the plate on its oral surface and at the anterior end this carina merges with a denticulate blade. The blade is somewhat incomplete on the figured specimen. The outer side of the plate is slightly flared laterally, accentuating the bowing of

the specimen. The inner margin (illustrated side) of the plate is essentially straight. This specimen resembles *P. webbi* Stauffer (particularly fig. 29 on pl. 53) from the Olentangy shale, but the aboral surface of *P. percarinnata* is more strongly keeled and does not possess the secondary keels or ridges around a longitudinal aboral excavation as in the former species.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Holotype.—State Univ. Iowa, 4052.

POLYGNATHUS ROTUNDILOBA Bryant
Plate 26, figure 6

Polygnathus tuberculatus HINDE [part], 1879, Geol. Soc. London Quart. Jour., vol. 35, p. 366, pl. 17, fig. 10.

Polygnathus rotundilobus BRYANT [part], 1921, Buffalo Soc. Nat. Sci. Bull., vol. 13, pp. 26–27, pl. 12, figs. 1–6 [not text fig. 7].

Polygnathus rotundilobus HOLMES, 1928, U. S. Nat. Mus. Proc., vol. 72, art. 5, p. 18.

Polygnathus tuberculatus HOLMES [part], 1928, U. S. Nat. Mus. Proc., vol. 72, art. 5, p. 37, pl. 7, fig. 19 [not fig. 18].

Polygnathus rotundiloba HUDDLE, 1934, Bull. Am. Paleontology, vol. 21, no. 72, pp. 17, 102–103, pl. 8, figs. 36, 37.

The prominent blade is composed of about five denticles which are much compressed laterally and fused nearly to their apices; the blade extends posteriorly on the plate as a progressively diminishing carina. The plate proper is roughly triangular and its surface is nodose. This form resembles the several examples of the species which have been recorded, and it agrees particularly well with most of the specimens illustrated by Bryant from the Genesee beds of New York. Variations in this generalized plate-like species indicate that it may be related also to early forms of *Ancyrodella* such as *A. buckeyensis* Stauffer which has been described from the Olentangy shale of Ohio and from an Upper Devonian shale near Middle Amana, Iowa.

Occurrence.—Known to occur in the Genesee of New York, the New Albany shale of Indiana and an Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Hypotype.—State Univ. Iowa, 4053.

POLYGNATHUS SPATULATA
Younquist, n. sp.
Plate 26, figure 4

This species is characterized by the presence of a large and well developed blade This blade is thin, high, sharpened aborally into a small keel and composed of about eight denticles. The denticles increase in height and width toward the midpoint of the blade. They are fused nearly to their apices but when viewed by transmitted light are seen to retain their individuality to a point about half-way aborad in the blade. The platform is broad and shallowly concave. The oral carina is not well developed but it extends as a slight ridge the entire length of the plate. This species has an aboral keel which enlarges slightly beneath the anterior end of the platform proper to encompass a small escutcheon. The entire specimen is slightly arched and bowed. The specimen, which is illustrated from the inner side, is complete.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Holotype.—State Univ. Iowa, 4054.

POLYGNATHUS SPINULOSA
Youngquist, n. sp.
Plate 24, figure 9

The plate is lance-shaped, being narrowly triangular in outline. The oral surface of the plate bears nodes which are long to the extent of being spike-like. The nodes are rather closely spaced in an irregular manner giving the plate a spinose appearance. The blade is sharply crenulated on its oral side and is made up of about six denticles which do not differ greatly in hue from the amber colored material of the lower portion of the blade and of the plate. The entire specimen is both bowed and arched and its aboral surface is slightly keeled. At the point of junction of the plate with the blade, a small escutcheon is present, and also at this point small secondary keels extend laterally along the anterior margin of each of the anterior lobes of the plate. The figured holotype is essentially complete but the anterior aboral end of the blade and a small portion of one of the anterior lobes of the plate are missing.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Holotype.—State Univ. Iowa, 4055.

POLYGNATHUS sp.
Plate 24, figure 10

Blade-like conodont fragments, such as

the one illustrated, are usually common in faunas containing abundant representatives of the genera *Polygnathus*, *Ancyrodella*, and *Palmatolepis*. These conodonts are a combination of blade and platform and very often the blade is broken away. The blade illustrated is very much compressed laterally and it retains nine denticles which are confluent the greater part of their length. A ridge-like thickening is evident rising from about the midlength of the blade on the aboral margin and continuing in arcuate form to the anterior end. Probably this blade belongs to a form not unlike the complete specimen of *Polygnathus spinulosa* illustrated by figure 9 on the same plate.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 4056.

PRIONIODINA sp.
Plate 26, figure 7

The anterior limb of the bar is somewhat larger than the posterior limb. The denticles and the cusp are laterally compressed and all incline posteriorly at a slight angle. The cusp extends aborally on the outer side of the bar in the form of a slight process and the region of the bar beneath the cusp is excavated. The fragmental denticles which are preserved indicate that the denticles were laterally compressed, subequal in size, and in general not much smaller than the cusp.

Occurrence.—Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Repository.—State Univ. Iowa, 4057.

PRIONIODUS ALATUS Hinde
Plate 26, figure 11

Prioniodus? alatus HINDE, 1879, Geol. Soc. London Quart. Jour., vol. 35, p. 361, pl. 16, fig. 5.
Prioniodus? alatus GRABAU, 1899, Buffalo Soc. Nat. Sci. Bull., vol. 6, p. 153, fig. 331.
Prioniodus alatus GRABAU and SHIMER, 1910, North Am. index fossils, invertebrates, vol. 2, pp. 243, 244, fig. 1533b.
Prioniodus alatus BRYANT, 1921, Buffalo Soc. Nat. Sci. Bull., vol. 13, p. 15, pl. 3, fig. 10, pl. 4, figs. 1–7.
Prioniodus alatus ULRICH and BASSLER, 1926, U. S. Nat. Mus. Proc., vol. 68, art. 12, p. 11, pl. 1, figs. 25, 26.
Prioniodus alatus HOLMES, 1928, U. S. Nat. Mus. Proc., vol. 72, art. 5, p. 20, pl. 3, fig. 40.
Prioniodus alatus BRANSON and MEHL, 1933, Missouri Univ. Studies, vol. 8, no. 2, p. 134, pl. 11, fig. 13.
Prioniodus alatus HUDDLE, 1934, Bull. Am. Paleontology, vol. 21, no. 72, pp. 14, 21, 37, pl. 1, figs. 1–3.
Prioniodus alatus COOPER, 1939, Jour. Paleontology, vol. 13, pp. 404, 420, pl. 45, fig. 55, pl. 46, figs. 6, 8.
? Prioniodus cf. P. alatus HASS, 1943, Jour. Paleontology, vol. 17, p. 308.
Prioniodus alatus QUIGLEY, and MEHL and QUIGLEY respectively, 1944, *in* BRANSON, Missouri Univ. Studies, vol. 19, no. 3, p. 158, pl. 27, figs. 43? 46, 47 [42, 45, 46].

The specimen illustrated is fragmentary but preserves all of the anticusp, a large portion of the cusp and parts of three denticles. The cusp and the denticles are laterally compressed and confluent with one another near their bases. One or two germ denticles are visible in the bar between the cusp and the anterior erupted denticle. A considerable amount of variation is evident in the several specimens which have been referred to this species. This Iowa form is perhaps closest to the specimen illustrated by Bryant (1921, pl. 4, fig. 6).

Occurrence.—Genesee and Portage beds of New York, New Albany shale of Indiana, Snyder Creek shale and Sylamore sandstone of Missouri, and "pre-Welden" shale in Oklahoma. Occurs also in an Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa. This species was inadvertently listed by Cooper (1939, pp. 419–420) as being from the Hardin sandstone of Tennessee and the Genesee shale of Ontario, but presumably this reference is to specimens which have been described from the Rhinestreet shale of New York and the Genesee beds of New York, respectively.

Hypotype.—State Univ. Iowa, 4058.

SPATHOGNATHODUS GRATIOSUS (Stauffer)
Plate 26, figure 1

Pandorina gratiosa STAUFFER, 1940, Jour. Paleontology, vol. 14, p. 428, pl. 59, figs. 18–20, 24.

This form is represented by a single individual in the collection at hand which agrees closely with the specimen described from the Devonian of Minnesota. The denticles on the posterior portion of the blade are 11 in number, deeply inserted, laterally compressed and fused nearly to the apices. The cusp is broad, somewhat recurved posteri-

orly and partially confluent with a denticle on its anterior margin. The anterior portion of the blade is short and bears two closely fused denticles. The aboral margin of the blade posterior to the cusp is moderately flared laterally and encompasses a longitudinal groove which is deepest anteriorly. The suggestion (Ellison, 1946, p. 109) that these forms belong in *Spathognathodus* appears to be valid.

Occurrence.—Upper part of Cedar Valley limestone, Hickok quarry, LeRoy, Minnesota, and an Upper Devonian shale 1½ mi. northeast of North Liberty, Iowa.

Hypotype.—State Univ. Iowa, 4059.

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THE DISCOVERY AND SIGNIFICANCE OF A CEPHALOPOD FAUNA IN THE MISSISSIPPIAN CABALLERO FORMATION OF NEW MEXICO

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ABSTRACT—Four or five genera of nautiloids and two of ammonoids have been found in the Caballero formation of the Sacramento Mountains. These confirm the conclusion that this formation is Kinderhook in age and that its fauna is closely related to that of the Chouteau limestone of Missouri.

RECENTLY C. C. Branson sent us for study a group of cephalopods which he had collected in the Caballero formation of the Sacramento Mountains in south-central New Mexico. L. R. Laudon also loaned us a few specimens from the same general horizon and locality. The material thus assembled constitutes the basis for this report, and insofar as we have been able to ascertain it includes all of the cephalopods known from the Caballero, for none has been reported previously. Altogether, four or five genera of nautiloids (*Mooreoceras*, *Poterioceras?*, *Welleroceras*, *Triboloceras* and a new genus termed *Hesperoceras*) and two of ammonoids (*Gattendorfia* and *Pericyclus*) are represented in the collections we are studying.

The name Caballero was proposed in 1941 by Laudon and Bowsher for beds which had previously been regarded as the lower part of the Lake Valley formation. According to these authors, the Caballero is of widespread occurrence in southwestern New Mexico, and throughout the Sacramento Mountain area it consists of some 18 to 60 feet of gray nodular marly limestone, which lies at the base of the Mississippian section there. It is abundantly fossiliferous; and from exposures in the Sacramento Mountains Laudon and Bowsher list 6 species of corals, 5 of crinoids, 39 of brachiopods, 1 of pelecypods, 4 of gastropods, 1 of conularids, and 1 of trilobites, and they add that in addition they have a large number of forms that are new or represent varieties of described species. They state that more than 30 of the 57 species they list can be considered as characteristic of the Kinderhook and 19 as Osage, whereas 6 occur commonly in both of these groups; and they conclude that the fauna is predominantly Kinderhook in aspect and is most like that of the Chouteau formation of the Upper Mississippi Valley. Both of these conclusions are strongly supported by the cephalopods.

Many cephalopods of this age have been been illustrated and described from Eurasia and Africa, and they are perhaps best known from the Tournaisian of Belgium and Ireland. In North America Kinderhook nautiloids and ammonoids have been found to occur together in quantity in the Rockford limestone of Indiana and the Chouteau and Northview formations of Missouri and equivalent strata in adjacent portions of Iowa and Illinois. Certain other beds, for example, the Cuyahoga group of Ohio and the Marshall sandstone of Michigan, have also yielded a few species.

The majority of the specimens in the Caballero collections we are studying are fragmentary orthocones. Most of these represent relatively long slender conchs, for they are gradually expanded orad. In all cases where the siphuncle is visible, it is small at its passage through the septa. Furthermore, the conchs are for the most part circular, or nearly so, in cross section, and the sutures form simple circles as the septa are saucer-shaped disks normal to the long axis of the conch. These facts indicate that the specimens probably belong in the

genus *Mooreoceras*, which is abundant in the Chouteau and equivalent beds but is also well represented in Pennsylvanian and Permian strata. In size, our specimens vary greatly, which is probably of little significance. However, they also show a variation in the relative width of the camerae and in the position of the siphuncle (cf. figures 5 and 7 on plate 28), which is of considerable taxonomic importance and indicates clearly that more than one species is represented. The only one of these specimens that preserves much of the living chamber (Pl. 27, fig. 8) has a broad shallow rounded transverse constriction near its adoral end; and it is perhaps significant that similar constrictions occur in several of the congeneric forms known from the Chouteau, but not in those that have been described from later beds. The adoral camera of this constricted specimen is short (which indicates that we are dealing with a mature individual), and the siphuncle is central in position.

One of the Caballero orthocones (Pl. 27, figs. 1–3) is unique in that its conch is subrectangular in cross section, and its sutures form rather prominent lobes. We are describing this specimen below and coining for it the name *Hesperoceras laudoni*, n. gen. and n. sp.

Some of the other fragmental orthocones are rather rapidly expanded orad (Pl. 27, fig. 7). All of these are broadly elliptical in cross section, and they have central siphuncles which are small at their passage through the septa. The affinities of these specimens are somewhat uncertain, but it seems probable that they are all referable to the genus *Poterioceras*, which is well represented in the Chouteau and Northview formations of Missouri but ranges up into the Pennsylvanian. It should perhaps be stated that in some of the known representatives of *Poterioceras*, for example, *P. subrectum* Miller and Furnish of the Chouteau, the conch is essentially straight except in its extreme adapical portions which are distinctly curved, somewhat as in *Pseudorthoceras* of the Pennsylvanian and Permian.

The large specimen represented by figure 4 on plate 27, is strikingly similar to one of the paratypes of *Welleroceras liratum* Miller and Furnish of the Chouteau of Missouri (see Miller and Furnish, 1938, pl. 48, fig. 3). In both of these individuals the conch is broadly elliptical in cross section, the sutures are straight and directly transverse, and the siphuncle is central or nearly so. Our Caballero specimen seems to have slightly shorter camerae than does the Chouteau individual, but almost certainly they belong in the same species. It should probably be stated that the Caballero specimen is slightly crushed and that no trace of its surface ornamentation is retained.

From many points of view, the most significant nautiloids known from the Caballero are several specimens that belong in *Triboloceras*, a genus which in America, at least, has been found only in the Kinderhook. Most of our Caballero specimens are worn and rather incomplete, but their generic characters are definite—they have rather loosely coiled conchs that bear prominent longitudinal ridges and are more or less semicircular in cross section, their sutures are sinuous, and their siphuncles are small and are located slightly ventrad of the center of the conch. The individual we are illustrating (Pl. 27, figs. 5, 6) is well preserved, and it is clearly referable to *T. digonum* (Meek and Worthen). That species was originally described from the Rockford limestone of Indiana, and it has since been found in the Chouteau and Northview formations of Missouri and in contemporaneous beds in Illinois. Miller and Furnish (1938, pp. 153–156) established a number of varieties of this species, and our illustrated specimen belongs in their *T. digonum subcirculare*, which is the most abundant form in the Chouteau limestone.

Only two goniatites have so far been found in the Caballero formation. Fortunately, they represent distinct genera, both of which have a wide geographic distribution and a short stratigraphic range. One of these two specimens (Pl. 28, figs. 8–10) has a fairly smooth subglobular conch, whereas the other (Pl. 28, figs. 1, 2) is subdiscoidal and bears prominent ribs. The former is described below as a new species of *Gattendorfia*, *G. bransoni*. Although the genus *Gattendorfia* was established by Schindewolf in 1920, it was not recognized outside of Germany until Librovitch (1940, pp. 225–243) reported it from the Central Asiatic portion of Soviet Russia and pointed out (pp. 231–

232) that some of the poorly known forms from the Kinderhook of Indiana, Ohio, and Missouri probably belong in it. The collections of the University of Missouri contain undescribed specimens from both the Chouteau limestone and the Northview sandstone that are clearly referable to this genus and resemble the Caballero form.

The ribbed goniatite found in the Caballero is strikingly similar to the only specimen of *Pericyclus* previously described from America, the holotype of *P. blairi* (Miller and Gurley). That specimen, unfortunately, does not retain its sutures, and only the umbilical portions of the sutures are visible on our Caballero individual. The published illustrations of the holotype of *P. blairi* leave much to be desired. However, the specimen is in the collections of the University of Cincinnati, and also there are two small specimens at the University of Missouri that presumably are conspecific. A comparison of these three specimens with the one we are studying from the Caballero leaves no doubt in our mind but that all are closely related. Our specimen seems to have a somewhat larger umbilicus than does the holotype of *P. blairi*, but that holotype was crushed and distorted during preservation, and it seems probable that the difference between the two is more apparent than real. In Europe, where Lower Carboniferous ammonoids have been studied a great deal, the genus *Pericyclus* is regarded as characteristic of a zone between the so-called zone of *Protocanites* and that of *Beyrichoceras*. However, in America, *Protocanites* and *Pericyclus* occur together in the Chouteau, though it should perhaps be kept in mind that none of the three Chouteau specimens that are referred to *Pericyclus* retains its sutures.

The Caballero cephalopods we are studying came from only a few localities, all of which are in one relatively small area, the Sacramento Mountains of south-central New Mexico. Specimens that seem to be referable to *Mooreoceras* were collected by Laudon in Mule Canyon and from the north wall of upper Marble Canyon. He also found a questionable representative of *Posterioceras* in Dog Canyon on the western slope of the range, and a few miles to the north in Deadman branch, Alamo Canyon, he secured the only known representative of *Hesperoceras laudoni*. Branson's collections came from four localities, all of which are in T. 16 S., R. 10 E., Otero County. In section 14 he found *Mooreoceras* sp., *Posterioceras?* sp., and *Gattendorfia bransoni;* in section 22 he obtained (from the upper part of the formation) *Mooreoceras* spp., *Posterioceras?* sp., and *Triboloceras digonum semicirculare;* and on the slope south of Marble Canyon, that is, in the NW ¼ NW ¼ section 26 he collected (in the upper 10 feet of the formation) *Mooreoceras* spp., *Posterioceras?* sp., *Welleroceras liratum*, *Triboloceras digonum*, and *Pericyclus* cf. *P. blairi;* and in the SE ¼ of the same section as the preceding he secured *Mooreoceras* sp. and *Posterioceras?* sp.

The lithology of the specimens from all the above-listed localities is quite similar. Furthermore, the faunas obtained at these localities are even more alike than these lists imply, and there is no reason to doubt that we are dealing with but a single faunal invasion. The striking similarity of the cephalopods from the Caballero of New Mexico to those known from the Chouteau of the Upper Mississippi Valley indicates clearly that the containing beds in these two widely separated regions are essentially contemporaneous.

DESCRIPTIONS OF A NEW GENUS AND TWO NEW SPECIES

Genus HESPEROCERAS Miller and Youngquist, n. gen.

Conch orthoceraconic, and subrectangular in cross section. Sutures straight and transverse (or nearly so) on narrow sides of conch but form broad shallow rounded lobes on wide sides. Siphuncle central in position and small at its passage through the septa. At present, genus is known only from the Caballero formation of New Mexico.

Superficially this form resembles *Loxoceras* M'Coy and *Euloxoceras* Miller, Dunbar, and Condra. However, in the genotype of *Loxoceras* the sutures form a lobe on only one side of the conch and the siphuncle is not central in position. The only known species of *Euloxoceras* has oblique sutures, and its siphuncle also is not central in position.

The orientation of the conch in the new genus is uncertain, there being two planes of bilateral symmetry. Unfortunately, no trace of the growth-lines is retained by the only

known representative of the genus, and therefore the location of a hyponomic sinus (if one existed) can not be determined. It might seem logical to assume that one of the broader sides is ventral, but in *Euloxoceras*, which has a similarly shaped conch, one of the narrower sides is ventral.

HESPEROCERAS LAUDONI Miller and Youngquist, n. sp.
Plate 27, figures 1–3

This species is based on an internal mold of five camerae. The overall length of the specimen is about 22 mm. The preserved portion of the conch is straight and relatively long and slender. It is flattened on four sides, but is rounded both dorsolaterally and ventrolaterally. In cross section it is subrectangular as one of its transverse axes is considerably longer than the other. At the adapical septum of the holotype, these two measure about 9½ mm. and 13 mm. Near the adoral end of this specimen, the longer of these axes measures about 15 mm., indicating that the rate of expansion of the conch is not great.

No trace of the test or the surface markings thereof is retained on the holotype. The camerae of this specimen are fairly uniform, and their average length is about 4 mm. On one of the narrower sides of the conch (Pl. 27, fig. 2), the sutures are essentially straight and directly transverse; whereas on the opposite side (Pl. 27, fig. 3) they are slightly oblique, probably due to distortion. On both of the wider sides of the conch, the sutures form broad rather shallow rounded lobes (Pl. 27, fig. 1).

The siphuncle is central in position, and at its passage through the septum that forms the adoral end of the holotype it is only about 1½ mm. in diameter. The structure of the siphuncle was not determined, for we were reluctant to section the only specimen available.

Remarks.—The holotype of this species appears to differ from all previously described forms to the extent that little could be gained by detailed comparisons. It can be distinguished from other orthoceratoids by means of its subrectangular cross section, transverse sinuous sutures, and central siphuncle which is small at its passage through the septa.

Occurrence.—Caballero formation in Deadman branch, Alamo Canyon, Sacramento Mountains, New Mexico.

Holotype.—Collection of L. R. Laudon at The University of Kansas.

GATTENDORFIA BRANSONI Miller and Youngquist, n. sp.
Plate 28, figures 8–10

The single specimen on which this species is based is a completely septate internal mold which is only moderately well preserved in limestone. The conch is subglobular in shape and is rather rapidly expanded orad. The maximum diameter of the holotype measures about 27 mm. A cast of the umbilical depression, which adheres to one side of this specimen, shows that when complete the conch formed at least one more volution.

The whorls are depressed dorsoventrally, broadly rounded ventrally and ventrolaterally, subangular dorsolaterally, and impressed dorsally. Near the midlength of the

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EXPLANATION OF PLATE 27

All specimens illustrated are from the Caballero formation of Otero County, New Mexico. That represented by figures 1–3 is in the collection of L. R. Laudon at The University of Kansas; the others are to be deposited at the University of Missouri. The photographs were retouched by Howard Webster.

FIGS. *1–3*—*Hesperoceras laudoni* Miller and Youngquist, n. gen. and n. sp., ×2; from Deadman branch, Alamo Canyon. (p. 116)

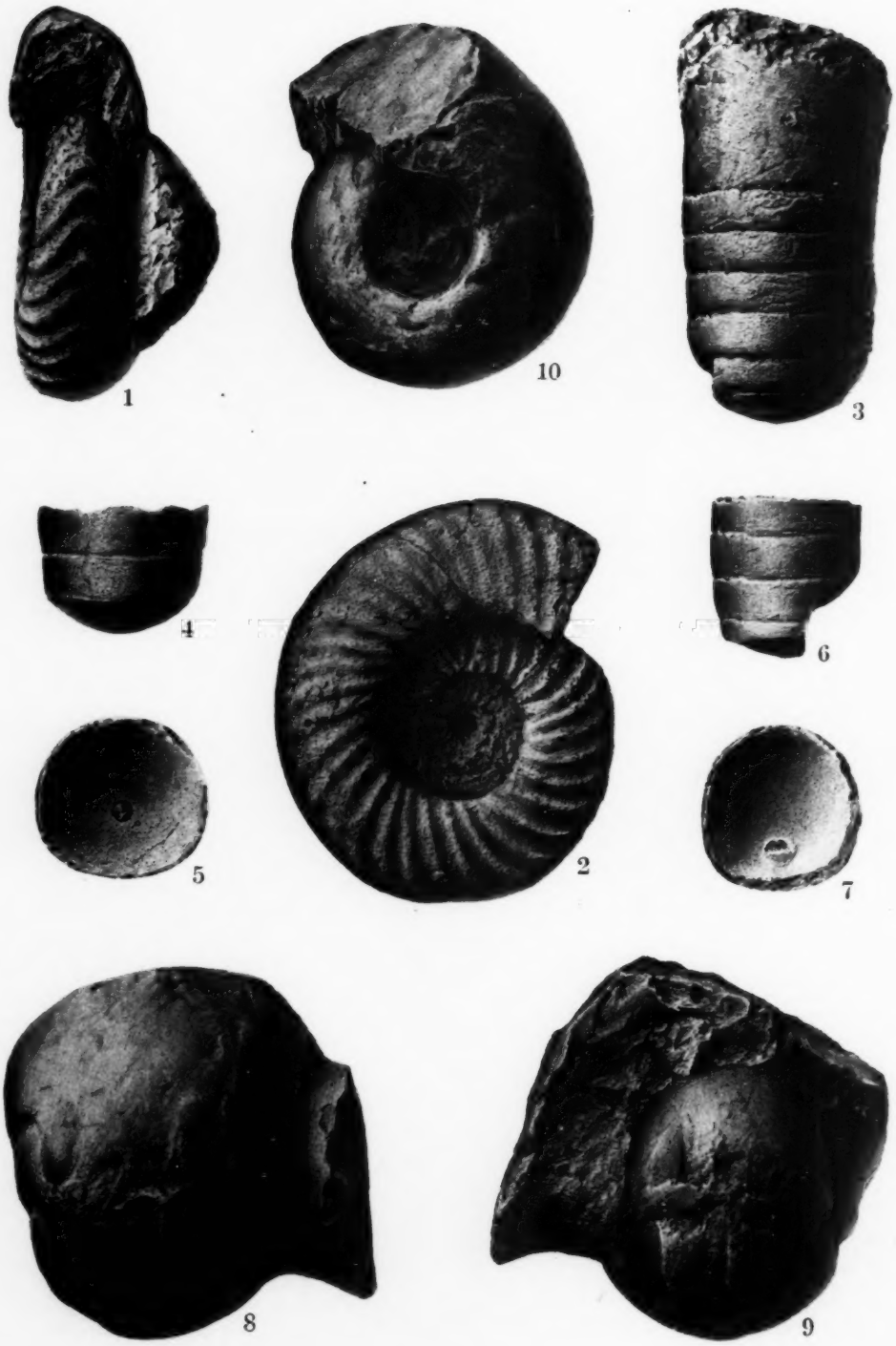
4—*Welleroceras liratum* Miller and Furnish, ×1; from the NW. ¼ NW. ¼ sec. 26, T. 16 S., R. 10 E. (p. 114)

5, 6—*Triboloceras digonum semicirculare* Miller and Furnish, ×1½; from sec. 22, T. 16 S., R. 10 E. (p. 114)

7—*Polerioceras?* sp., ×1; from the same locality as figure 4. (p. 114)

8—*Mooreoceras* sp., ×1; from the same locality as the preceding. (p. 114)

Miller and Youngquist, Mississippian Cephalopods



Miller and Youngquist, Mississippian Cephalopods

outer volution of the holotype the conch is about 17 mm. wide and some 6 mm. high. The umbilicus is moderately large, and its diameter is equal to about one-third that of the conch. The umbilical shoulders are abrupt and almost subangular. The umbilical walls are steep and are slightly convex. As shown by figure 8 on plate 28, at least part of the surface of the test bears transverse lirae.

The ventral portion of the sutures is not well preserved, but each external suture appears to form a deep narrow almost parallel-sided pointed ventral lobe, and on either side of it a U-shaped first lateral saddle, a more or less V-shaped first lateral lobe (which is shorter than the ventral lobe), a rounded asymmetrical second lateral saddle, and a small pointed lobe on (or just inside) the umbilical shoulder. Traces of the internal sutures preserved on the holotype indicate that they consist of a deep pointed ventral lobe and on either side of it a similar but somewhat shorter internal lateral lobe.

Remarks.—This form seems to resemble very closely the type species of the genus *Gattendorfia*, *G. subinvoluta* (Münster), of the basal portion of the Lower Carboniferous of Germany and possibly the Central Asiatic part of Soviet Russia. Also, it is similar to undescribed congeneric forms from the Chouteau and the Northview formations of Missouri that are in the collections of the University of Missouri.

Occurrence.—Caballero formation in sec. 14, T. 16 S., R. 10 E., Otero County, New Mexico.

Holotype.—University of Missouri.

MANUSCRIPT RECEIVED MARCH 27, 1946

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EXPLANATION OF PLATE 28

All specimens illustrated are from the Caballero formation of Otero County, New Mexico, and they are to be deposited at the University of Missouri. The photographs were retouched by Howard Webster.

FIGS. *1, 2*—*Pericyclus* cf. *P. blairi* (Miller and Gurley), ×2; from the NW. ¼ NW. ¼ sec. 26, T. 16 S., R. 10 E. (p. 115)

3—*Mooreoceras* sp., ×1; from the same locality as the preceding. (p. 114)

4, 5—*Mooreoceras* sp., ×1½; from the same locality as the preceding. (p. 114)

6, 7—*Mooreoceras* sp., ×1; from the same locality as the preceding. (p. 114)

8–10—*Gattendorfia bransoni* Miller and Youngquist, n. sp., ×2; from sec. 14, T. 16 S., R. 10 E. (p. 116)

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CRETACEOUS FOSSIL HORIZONS IN THE MACKENZIE RIVER VALLEY

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ABSTRACT—Cretaceous fossils collected from Mackenzie River valley exposures during the Canol Project explorations are identified, their stratigraphic correlations are considered, and two new species are described.

INTRODUCTION

ROCKS of Cretaceous age have a wide distribution in the valley of the Mackenzie River. The area underlain by Cretaceous strata is shown in considerable detail on the new Geological Map of Canada #820A, published in 1945 by the Department of Mines and Resources, Ottawa. The black shales, now known to be Cretaceous, were noted by early explorers in the area and Meek in 1859 described two ammonites from these beds but could not be precise as to their age. Since that time several geologists have reported Cretaceous beds from various localities but on account of the reconnaissance nature of the surveys conducted, no details of the strata referred to the Cretaceous have been published. It is known that there are many hundreds of feet of dark shale, sandstone and some conglomeratic beds comprising the section referred to the Cretaceous and that fossils are usually fragmentary and scarce. In 1937 the writer described some ammonites, referable to the genera *Beudanticeras* and *Deshaysites*, collected from the Cretaceous beds on Great Bear lake and from exposures on Mackenzie river. I correlated the fauna with a similar one occurring in the Cretaceous beds on Peace and Athabaska rivers in Alberta which had long been considered Aptian in age (3). More recently the species referred to *Deshaysites* has been ascribed to a new genus, *Lemuroceras*, and the fauna is considered to be Albian in age (6, 8).

Lately, further collections from the Mackenzie Cretaceous have come to hand, especially from geologists of the Canol Project These have considerably increased our knowledge of the fauna from that area. A summary of some of the results of the study of these collections is included in this paper.

THE FAUNAS AND THEIR AGES

Specimens in the collections studied have not been collected and labelled stratigraphically but according to locality. It was necessary, therefore, to separate the specimens into their proper geological horizons from our knowledge of other sections where stratigraphical horizons are known and where the same species occur. This was not difficult as most of the species represented in the collections are already well known. The age of such new species as are present, could be determined by their occurrence in collections from localities where the ages of most of the species have already been determined.

The species in the collections divide themselves readily into two distinct faunas, the lower one of Albian age and an upper one of Turonian age. The Albian fauna appears to be the most wide spread and contains the following species:

Inoceramus concentricus Pack.?
Pleuromya borealis Warren, sp. nov.
Beudanticeras affine (Whiteaves)
Beudanticeras glabrum (Whiteaves)
Beudanticeras robustum Warren sp. nov.
Gastroplites cf. *stantoni* McLearn
Gastroplites sp. not determined
Lemuroceras macconnelli (Whiteaves)
Puzosia? sp.
Sonneratia? sp.

The fauna listed above may be correlated with an Albian fauna from the Cretaceous section on Peace river in Alberta and British Columbia which has been studied in recent years by McLearn (3, 6). On Peace river the species listed above are divided into two distinct faunas; the first, including the genus *Beudanticeras* and *Lemuroceras macconnelli* occurs in the Loon River shale and the basal beds of the overlying Peace River sandstone; the second, including the genus *Gastroplites* is contained in the upper beds of the Peace

River sandstone and the lower beds of the overlying Fort St. John shale. A third fauna, containing the genus *Neogastroplites* and considered Albian in age, is found in the upper beds of the Fort St. John shale and possibly in the basal beds of the overlying Dunvegan sandstone. No trace of the *Neogastroplites* fauna has been observed in the collections from Mackenzie river. Judging from the locality number on the Mackenzie river collections, the *Beudanticeras* and *Gastroplites* faunas are much more closely associated in the northern area than they are on Peace river.

The Turonian fauna comprises the following identifiable species:

Inoceramus corpulentus McLearn
Inoceramus labiatus Schlotheim
Inoceramus tenuiumbonatus Warren
Inoceramus tyrrelli Warren
Pecten cf. *silentiensis* McLearn
Scaphites delicatulus Warren
Watinoceras reesidei Warren
Watinoceras cf. *coloradoensis* (Henderson)
"*Belemnites*" sp.

The fauna listed above may be correlated with the Turonian fauna occurring in the lower beds of the Smoky River shale in Peace River valley. In that area the character of the Turonian fauna has changed considerably from that of its occurrence through the Western Interior States and southern Alberta by the introduction of many new species (2, 10, 12). This "boreal" aspect of the Turonian fauna is reflected, also, in the collections from the Mackenzie valley. The species with the wide lateral distribution which serve to correlate the "northern" and the "southern" Turonian are the ubiquitous *Inoceramus labiatus* and *Watinoceras reesidei* or *W. coloradoensis*. The latter genus is proving a very useful index fossil for the base of the Turonian in western North America (5, 12).

An interesting feature of the Mackenzie collections is the total absence of any species which may be referable to Cenomanian time. In Peace River valley the Cenomanian is well represented by an extensive fauna, mostly of pelecypods, which is contained in the Dunvegan sandstone but extends slightly into the overlying Smoky River shale and perhaps also into the underlying Fort St. John shale (12). The principal ammonite of this fauna is *Dunveganoceras*. The absence of the *Dunveganoceras* fauna in the Mackenzie valley is probably the result of non-deposition at that time. The Dunvegan sandstone is a shoreline deposit with some non-marine beds, representing a partial withdrawal of the sea. Farther north the withdrawal may have been complete with a corresponding erosive interval. Erosion may have been the cause of the absence of the *Neogastroplites* fauna of Upper Albian age in the northern area.

DESCRIPTION OF NEW SPECIES AND REMARKS ON THE IDENTIFICATION OF KNOWN SPECIES

Genus PLEUROMYA Agassiz

PLEUROMYA BOREALIS Warren, n. sp.

Plate 29, figures 1–4

Description.—Shell elongate, sub-oval robust with prominent inturned umbones situated considerably in advance of the mid-length of the shell; lower margin gently convex, posterior end quite sharply rounded, anterior margin tending to straighten vertically, anterior end obliquely truncated and flattened and sometimes slightly convex; junction of the truncated end and the flank of the shell abrupt on each valve and sometimes forming a slight ridge with a slightly depressed area behind it; one or sometimes two flattened or slightly depressed areas may be present on the flank of the shell, extending obliquely downward and backward from the umbones; posterior end usually slightly gaping. Ornamentation of shell as shown on the internal mold consisting of well defined and usually quite regular concentric ridges.

Dimensions of two syntypes:

	Length	*Height*	*Convexity* (both valves)
No. 1	55 mm.	35 mm.	28 mm.
No. 2	48 mm.	36 mm.	28 mm.

Remarks.—The reference of this species to the genus *Pleuromya* is doubtful and is based principally on the shape of the shell, type of ornament and the slight gape at the posterior end of the valves. *Pleuromya* is more typical of the Jurassic and its place is taken in the Cretaceous by the genus *Panope*.

P. borealis seems to be quite variable. The common form is typical of *Pleuromya* and

the dimensions are as given for specimen No. 1. This form grades into another which is shorter and higher with from one to three flattened or slightly depressed areas passing from the umbones to the lower margin of the shell.

In comparison with other Cretaceous forms this species appears to be quite closely allied to *P. orbigniana* (Rouillier) as figured by Woods as it occurs in the Spilsby sandstone of England (14). The Mackenzie species is a little smaller, with a less pronounced gape at the posterior end. The concentric ornamentation is much stronger and there appears to be no radial ornament. The writer has had no opportunity to compare this species with the figure of the types of *P. orbigniana* from the Lower Volgian of Moscow.

Horizon and Locality.—Lower Cretaceous shales, *Beudanticeras* zone from different localities between Fort Norman and Fort Good Hope on Mackenzie river.

Types.—Syntypes. Ct. 523, 524 and 956.

Genus GASTROPLITES McLearn

In 1892 J. F. Whiteaves described some Cretaceous fossils collected on the Peace and Athabaska rivers and contiguous territory in northern Alberta (13). One of the species described was *Hoplites canadensis*. In subsequent years, this fauna has undergone further study and revision, and F. H. McLearn has placed the species *H. canadensis* in a new genus, *Gastroplites*, and has erected several new species attributed to this genus, all from the same general area (4).

In the collections from the Lower Mackenzie Cretaceous now at the University of Alberta, are many fragmentary ammonites which undoubtedly can be ascribed to the genus *Gastroplites*. Most of the specimens represent portions of the living chamber though some are, at least partially, septate. Two specimens apparently representing the innermost whorls of a species of *Gastroplites* are also present.

The specific determination of this material is difficult as McLearn's species were described from septate shells often without a complete knowledge of the living chamber. It is apparent that several species are represented in our collection but the writer cannot ascribe any of them to previously described species. Most of the specimens are compressed shells with flattened or slightly rounded venters, ribs dividing on the flanks or alternating in length, in some cases passing over the venter and in other cases terminating abruptly on the ventral shoulder. There is great variation in the size of the different specimens as preserved; some of this variation may be due to different stages of growth.

It is considered advisable to postpone any attempt to erect new species of *Gastroplites* in the fauna from the Mackenzie river, until more complete material has been collected and studied. The specimens on hand are sufficiently complete for generic diagnosis and therefore competent to attest an Albian age for the containing beds.

Genus BEUDANTICERAS Hitzel

The genus *Beudanticeras* is well represented in the Lower Cretaceous faunas from the Mackenzie valley. Representatives of this genus were described by Whiteaves from northern Alberta under the name *Desmoceras affine* and *D. affine* var. *glabrum* (13). The writer has already drawn attention to the occurrence of the genus in the Cretaceous rocks of the Mackenzie valley (11).

The specimens of *Beudanticeras* in our collections show a great variety in size and form. A good proportion are fragmentary. At least three species are believed to be represented in the collection but distinction between them is not clear and there are intermediate forms which are hard to place. The

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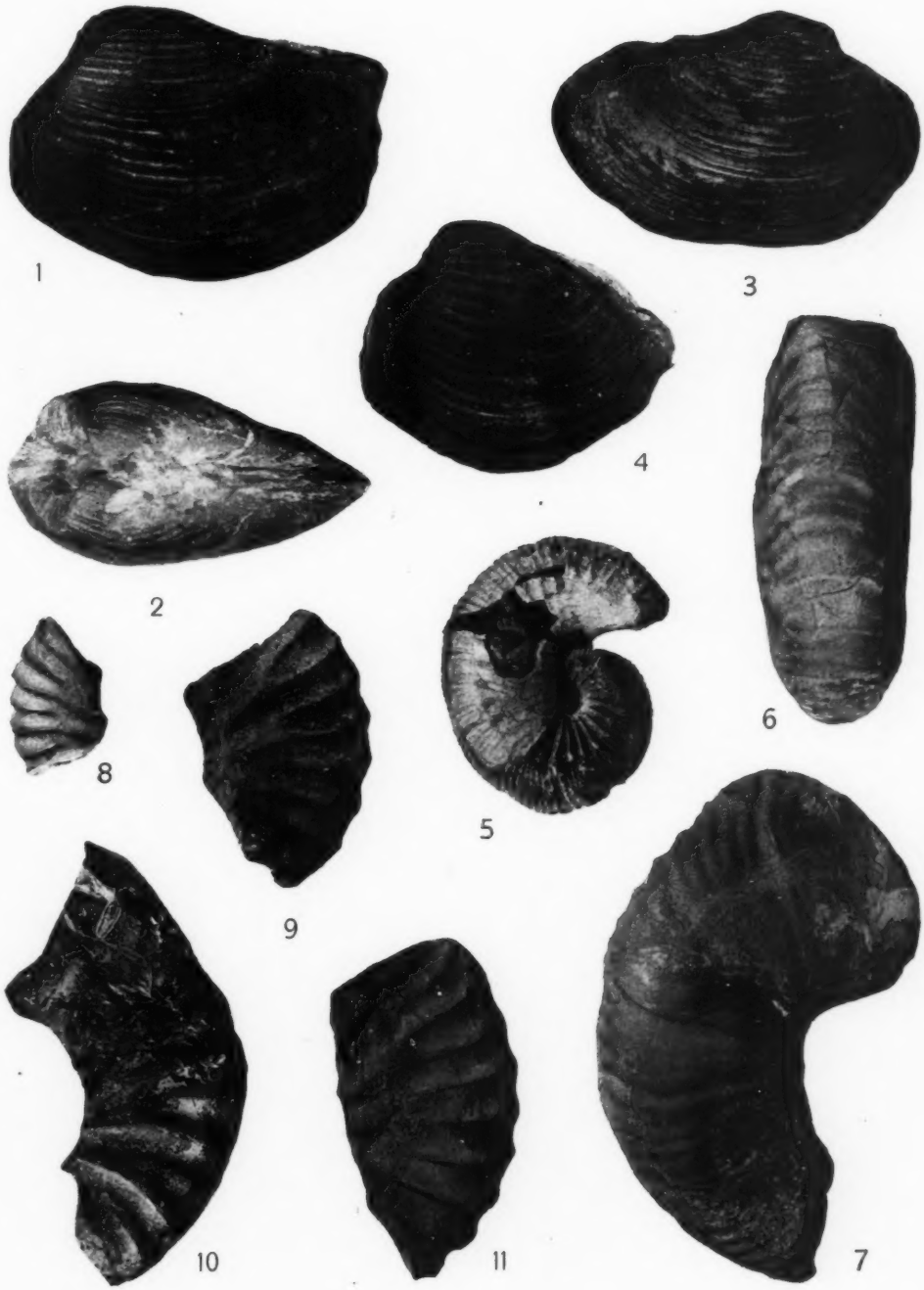
EXPLANATION OF PLATE 29

FIGS. *1–4*—*Pleuromya borealis* Warren n. sp. *1*, *2*, Syntype Ct. 523, left valve and dorsal view, posterior end imperfect; *3*, Syntype Ct. 524, posterior end imperfect; *4*, Syntype 956, showing radiating depression on imperfect posterior end. (p. 119)

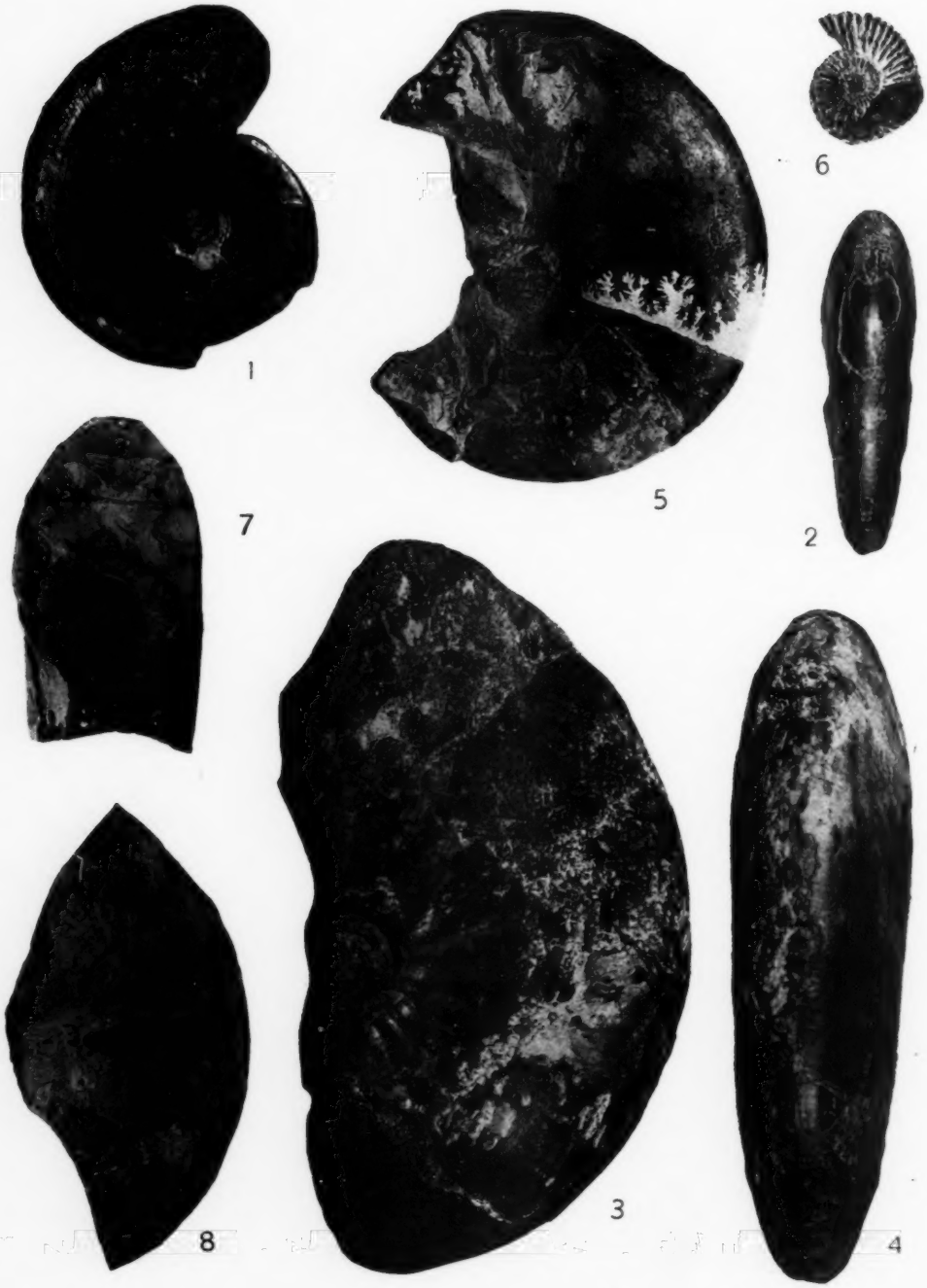
5—*Scaphites delicatulus* Warren. Large nearly perfect specimen, Ct. 959. (p. 123)

6, *7*—*Puzosia?* sp. Ventral and lateral views showing living chamber, Ct. 862. (p. 122)

8–11—*Gastroplites* spp. Fragments of living chambers attributed to this genus, figure 10 ×½. (p. 120)



Warren, Cretaceous Faunas



Warren, Cretaceous Faunas

basis of the division into species is, firstly, the shape of the shell, secondly, the constrictions or arrests of growth on the shell, and, thirdly, the character of the suture. The suture in all cases shows the wide lateral lobe, irregularly trifid and cut much deeper than the ventral lobe. Several auxiliary lobes may be present. *B. glabrum* (Whiteaves) is a strongly compressed shell with no growth constrictions and about five auxiliary lobes on the flanks of the shell. *B. affine* (Whiteaves) is a moderately compressed shell with growth constrictions and about three auxiliary lobes. *B. robustum* n. sp. is a more robust shell with growth constrictions and with no more than two auxiliary lobes. The size of the shell and the character of the umbilicus are variable and has not been taken into account in determining the species.

The earlier stages in the development of these species cannot be studied from our collections but it is quite probable that when such study can be made from more complete specimens, that the specific distinctions as given may not hold. The writer has observed one specimen of *B. glabrum* which in the later neanic stages has a strongly compressed whorl whereas a whorl in the earlier neanic stages is much more robust. Other specimens of *B. glabrum* on which the earlier stages can be observed, the inner whorls are strongly compressed.

BEUDANTICERAS GLABRUM (Whiteaves)
Plate 30, figures 1–4

Placenticeras glabrum Whiteaves, 1889. Cont. to Canadian Pal., vol. I, pt. 2, p. 172, pl. 24, figs. 1, 1a and b.

Desmoceras affine var. *glabrum* Whiteaves, 1892. Roy. Soc. Canada, 1st Ser., vol. 10, p. 115, pl. 9, figs.

Description.—A strongly compressed shell with narrowly rounded venter and a narrow umbilicus showing the internal whorls; ornamented with fine sigmoidal striae, some of which become coarser and more elevated on the flank of the shell near the umbilical border. Dimensions of the shell of two specimens are given in the following table:

Diameter	*Height of whorl*	*Greatest width of whorl*
53 mm.	26 mm.	15 mm.
112 mm.	58 mm.	33 mm.

Suture line typical for the genus with the first lateral lobe very wide and much deeper than the ventral lobe and irregularly trifid. About five auxiliary lobes are present. No growth constrictions.

Remarks.—Whiteaves considered that some of his specimens of the variety *glabrum* lacked the growth constrictions on account of abnormal compression but concludes that the presence or absence of such constrictions has no specific value. As, however, it is only on the more compressed shells that the constrictions are absent and such absence is usually accompanied by differences in sutural detail, it must be considered that there is specific distinction.

It cannot be demonstrated by our collections that the different species of *Beudanticeras* occur at different stratigraphic horizons.

Locality.—Widely distributed in the Cretaceous of the Lower Mackenzie valley.

BEUDANTICERAS AFFINE (Whiteaves)
Plate 30, figure 5

Desmoceras affine Whiteaves, 1892. Roy. Soc. Canada, 1st Ser. vol. 10, p. 113, pl. 8, pl. 11, figs. 1, 1a.

Description.—A moderately compressed, discoidal shell with moderately rounded venter and narrow umbilicus which shows the internal whorls; flanks subparallel; constrictions of growth usually well developed. Surface ornament as in *B. glabrum.* Dimen-

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EXPLANATION OF PLATE 30

FIGS. *1–4—Beudanticeras glabrum* (Whiteaves). *1, 2,* lateral and ventral views of young specimen showing sharply defined umbilical shoulder and lack of constrictions, Ct. 858; *3, 4,* lateral and ventral views of large specimen showing development of nodes along umbilical shoulder. (p. 121)

5—Beudanticeras affine (Whiteaves). A typical specimen showing moderately rounded umbilical shoulder, constrictions of growth and suture, Ct. 859, ×1½. (p. 121)

6—Watinoceras reesidei Warren. Lateral view of imperfect specimen, Ct. 959 (p. 122)

7—Beudanticeras? robustum Warren n. sp. Holotype, septal fragment, end and side views showing shape of whorl, Ct. 861 (p. 122)

sions of the shells of two specimens are given in the following table:

Diameter	*Height of whorl*	*Greatest width of whorl*
64 mm.	32 mm.	22 mm.
132 mm.	62 mm.	38 mm.

Suture line similar to that of *B. glabrum* except that there are usually not more than three adventitious lobes on the flank of the shell.

Remarks.—The greater stoutness of the whorl of *B. affine* is not well shown in the measurements. The greatest width of the shell in *B. glabrum* is at the umbilical shoulder whereas in *B. affine* it is some distance out on the flank. The more moderately rounded venter of the latter species also gives it a stouter appearance.

Locality.—Widely distributed in the Cretaceous beds in the lower Mackenzie valley.

Beudanticeras? robustum Warren, n. sp.
Plate 30, figures 7, 8

Description.—A fairly stout discoidal shell with moderately rounded venter and narrow umbilicus; whorl elliptical in cross section with umbilical shoulders sloping moderately; constrictions of growth present; surface ornament unknown. Species known only from a septate portion of whorl which had a diameter of about 72 mm. Dimensions of shell (internal mold):

Height of whorl	*Greatest width of whorl*
40 mm.	30 mm.

Suture line similar to that of *B. affine* except that the auxiliary lobes are limited to one on the flank of the shell, and at most to two on the umbilical slope.

Remarks.—This is a much stouter shell than that of *B. affine*, the whorl being nearly as wide as high. It is probably little more than a variety of the better known species. The umbilical slope is more abrupt than in *B. affine* but not so abrupt as in *B. glabrum*. It is very probable that this species should not be ascribed to the genus *Beudanticeras*, but the writer finds it difficult to place it in any other Albian genus.

Locality.—Peel river, Lower Mackenzie valley.

Type.—Holotype Ct. 861.

Genus Puzosia Bayle
Puzosia? sp.
Plate 29, figures 6, 7

Description.—A moderately compressed discoidal shell, with fairly wide umbilicus and a moderately rounded umbilical shoulder; whorl elliptical in cross section; constrictions of growth numerous; costae low, sigmoidal, crossing the venter, and four to five in number between growth constrictions. Dimensions of living chamber of only specimen known, measured at first septa:

Height	*Width*
27 mm.	23 mm.

Suture with first lateral lobe longer than ventral lobe. Auxiliary lobes not preserved.

Remarks.—The generic reference is questionable as the only specimen in the collection consists of part of a living chamber with the last septum partially preserved. The auxiliary lobes of *Puzosia* are quite diagnostic and they are not preserved on the specimen. This shell must be quite closely related to d'Orbigny's species *P. mayoriana* as shown by the general shape, dimensions and sculpture of the shell, but the restrictions of growth are much more numerous.

Locality.—Ramparts river, Lower Mackenzie valley.

Genus Watinoceras Warren
Watinoceras reesidei Warren
Plate 30, figure 6

Watinoceras reesidei Warren, 1930. Research Council of Alberta, Rept. No. 21, App. pp. 67, 68, pl. 3, fig. 2, pl. 4, figs. 9–12.

This little species of ammonite is represented in the collection by three specimens, all contained in rock and, therefore, not available for complete study. There seems little doubt, however, of the specific reference. These finds greatly extend the range of the species and enhance its use as a horizon marker for the base of the Turonian.

An external mold of a larger specimen of slightly different ornamentation demonstrates the probable presence of a second species of the genus. This form must be quite closely allied to *Watinoceras coloradoense* Henderson (1).

Locality.—All specimens collected from the Bear Rock area, Lower Mackenzie.

Genus SCAPHITES Parkinson (s.s.)
SCAPHITES DELICATULUS Warren
Plate 29, figure 5

Scaphites delicatulus Warren, 1930. Research Council of Alberta, Rept. No. 21, App. p. 66, pl. 3, fig. 3, pl. 4, figs. 7 and 8.

Two specimens in the collections appear to be identifiable with the species *S. delicatulus*. The cotypes of the species are largely internal molds whereas the present specimens have the shell well preserved. Both specimens have suffered some compression and the swelling at the base of the living chamber is not so conspicuous as in the types. The primary ribs and nodes tend to disappear toward the proximal end of the living chamber on the larger of the two specimens whereas on the smaller specimen the nodes and primary ribs are still distinct quite close to the mouth of the shell, though they are not so sharply defined at that place.

Locality.—Both specimens from the Bear Rock area, on the Lower Mackenzie, accompanied with *Watinoceras* and *Placenticeras?*

Genus SONNERATIA Bayle

Two specimens in our collections are doubtfully referred to Bayle's genus. Neither specimen is sufficiently complete for a complete diagnosis. Both specimens are probably referable to the same genus and species. They demonstrate that the shell was involute and strongly inflated, attaining a diameter of at least 90 mm. The width of the outer whorl exceeds the height but exact measurements are not attainable. Eight strong primary ribs are present at the umbilical shoulder, which bifurcate on the flank and cross the strongly arched venter with a slight bend forward. An occasional secondary rib is implanted between the primaries but they do not reach the umbilical shoulder.

The ornament of this shell is not unlike that of some species of *Gastroplites*, but the shape of the shell forbids a reference to that genus.

Locality.—Both specimens were obtained from the same locality, on Big Island, below San Sault Rapids. Mackenzie river.

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JOURNAL OF PALEONTOLOGY, VOL. 21, NO. 2, PP. 124–130, 21 TEXT FIGS., MARCH 1947

ADDITIONAL GRAPTOLITES AND HYDROZOAN-LIKE FOSSILS FROM BIG CANYON, OKLAHOMA

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ABSTRACT—About 3 miles south of Dougherty at the southeast edge of the Crusher Quarry at Big Canyon, Oklahoma, graptolites and hydrozoan-like fossils occur sparsely scattered through a thick bed of argillaceous limestone. Graptolites belonging to three genera, *Dictyonema*, *Didymograptus*, and *Tetragraptus* were described recently from this locality in the Journal of Paleontology (vol. 19, pp. 607–611). The present paper describes two more genera of graptolites and two genera which are referred tentatively to the hydrozoans.

THE difficult task of collecting the specimens described below was shared by J. O. Beach, Henry Phillips, and H. C. Manning. The fossils are so sparsely scattered through a thick bed of argillaceous limestone that it took several days of persistent collecting to obtain a relatively small faunule.

The trace of a thrust fault cuts diagonally across the quarry from southeast to northwest. The fossils were obtained from the southeastern edge of the quarry on the upthrown side of the fault in beds identified as the West Spring Creek limestone of Upper Arbuckle age. From the presence of pendent graptolites at the north side of the quarry, northeast of the fault, and from graptolite zones on U. S. Highway 77, the throw of the fault seems to have been at least 700 feet.

Both genera of graptolites considered here belong to the branching forms, the *Dendroidea*, and the hydrozoan-like forms are also branching types.

The graptolites have been assigned to two genera, *Dendrograptus* Hall and *Callodendrograptus* Decker, and the other forms to two genera, *Chaunograptus* Hall and *Mastigograptus* Ruedemann.

Class GRAPTOLITHINA Bronn 1846
Emend Lapworth 1875
Order DENDROIDEA Nicholson 1872
Genus DENDROGRAPTUS Hall 1865

Hall (1865, p. 126) has given a long description of this genus, the most significant part of which is quoted as follows:

Fronds simple or aggregate, consisting of a strong footstalk, which is sometimes furnished below with a distinct root or root-like bulb, and above is variously ramified, and subdivided into numerous branches and branchlets, which are slightly divergent; the whole producing a broad spreading shrub-like frond; (fronds sometime flabellate). Branches celluliferous on one side: cellules appearing sometimes as simple indentations on the surface, and sometimes distinctly angular with the denticles conspicuous. In some specimens the cellules are indicated by prominent pustule-like elevations, arranged along the center, or in alternate order on the face of the branch. Substance of the stipe and branches corneus, solid or tubular; surface striated.

These bodies present specific distinctions in strength of the stipe or stem, in the mode of bifurcation and number of branches, in the character of the surface, and in the general form of the frond.

DENDROGRAPTUS FILAMENTOSUS
Decker, n. sp.
Figure 1

This tiny colony has stipes that are narrow, and this suggests the specific name. The small size is shown by a length of only 11 mm. and a width of 4.5 mm. The stipes have a width of .25 mm. and most of the thecae have little, if any overlap. The thecae are numerous and short, occurring 24 in 10 mm. Bifurcation is somewhat irregular, but if the shorter branches are considered, it takes place generally at a distance of less than 1 mm., though for longer branches the distance is nearly 3 mm. The stipes curve, and have some rather marked bends in them. The bifurcation angle varies from a little less than 30° to over 40°. Depending on the way in which the stipes are bent, the thecae lie either directly in the line of the stipe, or the apertural margin may extend sharply beyond the edge in denticulate fashion. There seems to

EXPLANATION OF FIGS. 1–11

All specimens illustrated on the plates are from Big Canyon (formerly Crusher), Oklahoma.

FIGS. *1*—*Dendograptus filamentosus* Decker, n. sp. ×4. (p. 124)

5, 9—*Dendrograptus beachi* Decker, n. sp. Small colonies ×4. (p. 126)

6.—*Callodendrograptus crusherensis* Decker n. sp. fragment of paratype, ×4. (p. 126)

2, 11—*Mastigograptus dendrograptoides* Decker, n. sp. Figure 2, one side of the holotype, the reverse is shown on figure 17. Figure 11 a small fragment ×4. (p. 128)

8—*Mastigograptus dendrograptoides* var. *curvensus* Decker, n. sp., n. var. Small fragment of a colony ×4. (p. 128)

3, 4, 7, 10—*Chaunograptus trellisatus* Decker, n. sp. Figs. 3 and 10, small fragments ×4, Fig. 4, large colony ×4, Fig. 7, lower part of same colony ×8. (p. 130)

be no differentiation among the small thecae.

Remarks.—This tiny colony is the only representative of this species.

Holotype.—B-2337, Museum, University of Oklahoma.

DENDROGRAPTUS BEACHI Decker, n. sp.
Figures 5, 9, 16

The specific name is given in honor of J. O. Beach who did much to help collect the graptolites. The four colonies illustrated vary greatly in size. Their length varies from 14 to 24 mm. and their width from 5.5 to 18.5 mm. The stipes have a width of 0.4 to 0.5 mm. and the branches vary in length from 8 to 12 mm. Bifurcation is more common at 4 mm., but in some forms it may occur at intervals of as much as 9 mm. The bifurcation angle is generally about 30°. As a rule, the branches diverge and spread distally to leave an increasingly enlarged space between them. Thecae occur 12 to 14 in 10 mm., and they vary in the amount of overlap from very little to about ¼ the length of the thecae. Thecae vary considerably in length, but most of them are about twice as long as wide.

Remarks.—The general form shown in the figures of these two species of *Dendrograptus* seems to be that of the very earliest graptolites. Cumulative evidence from Cambrian graptolites from Texas, Tennessee, and Virginia seems to show that *Dendrograptus* antedated *Callograptus* and *Dictyonema*, and the two latter were probably developed in succession from *Dendrograptus*.

Cotypes.—B-2338, B-2339, B-2340, University of Oklahoma Museum.

Genus CALLODENDROGRAPTUS
Decker, 1945

The genotype is *Callodendrograptus sellardsi* for which the following description was given by the writer (Decker, 1945, pp. 28, 29):

> The new genus combines the characteristics of a *Callograptus* with those of a *Dendrograptus*. The specimens generally are coarse having broad irregular main stipes, some of which are nearly straight, but others are curved. Branching is irregular, and the branches are short and thickest. They remind one of a locust tree after the ends of the limbs have been broken off by the wind.
>
> Three kinds of thecae are present: the thecae are either inclined or normal to the stipe serving for regular feeding polyps, elongate slender bithecae, and enlarged thecae either swollen or elongate which are thought to represent gonothecae. *Callodendrograptus sellardsi*, the most common and characteristic species under the genus, is designated as the genotype.

CALLODENDROGRAPTUS CRUSHERENSIS
Decker, n. sp.
Figures 6, 14, 15, 18, 19, 21

This species has the open branching characteristic of *Dendrograptus* with many of the thecae more like those of *Callograptus*, some of them being inclined and others extending at right angles to the stipes.

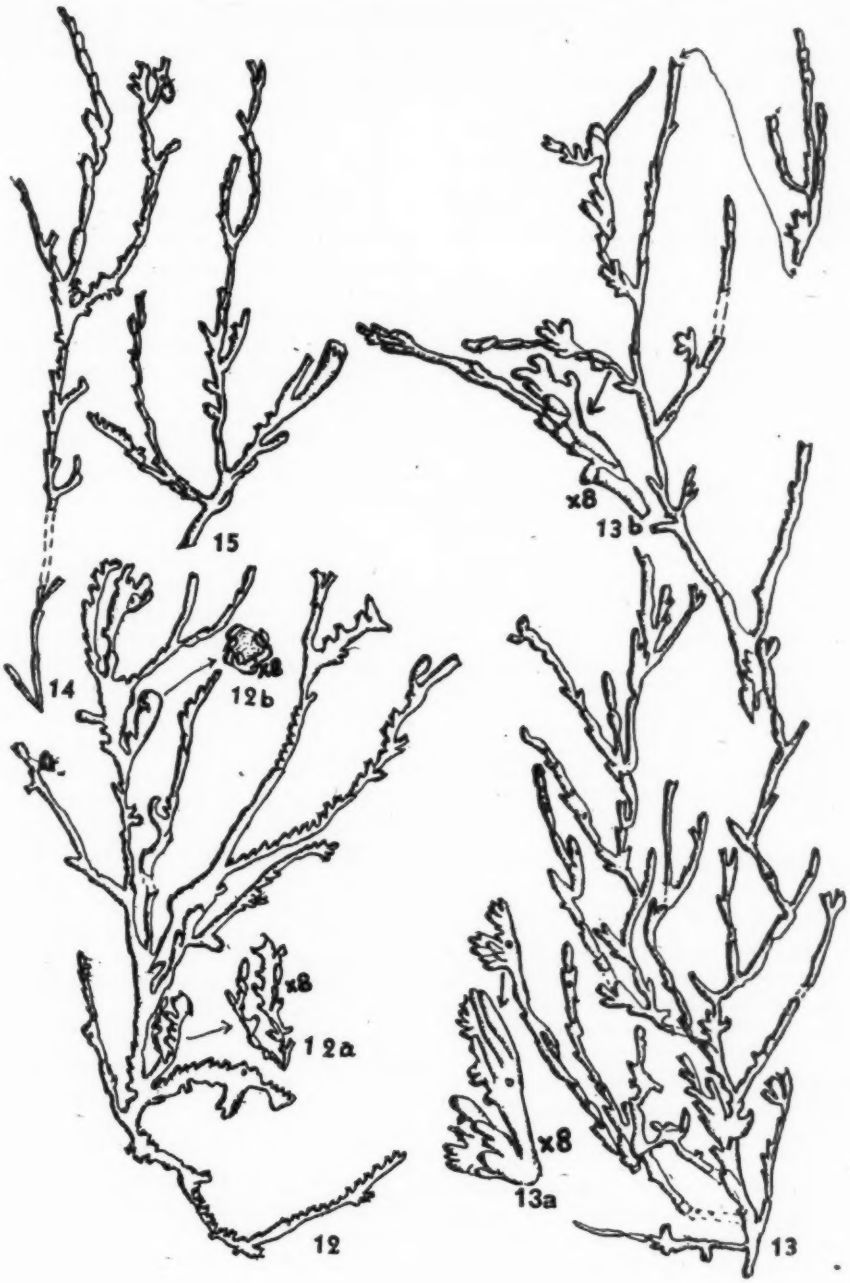
The length of the colonies varies from 16 to 81 mm. and the length of the branches from 6 to 17 mm. The stipes vary in width from 0.3 to 0.5 mm. Bifurcation is commonly at distances of 4 to 5 mm. The bifurcation angle is about 30° with a regularity that produces symmetrical shrub-like colonies. Thecae for the feeding polyps occur 16 to 24 in 10 mm. Also, there are narrow elongate bithecae, thought to respresent protective nematocysts, or stinging cells, and some large swollen reproductive gonothecae. The bithecae measure about 0.1 mm. in width and 0.7 mm. in length, while the gonothecae are about 0.5 mm. wide and 1.6 mm. long. Some thecae have no overlap, while others overlap from ¼ to ½ their length. The specimen illustrated in figure 6, has thecae very characteristic of the genus, and doubtless represents a fragment of a colony.

Remarks.—These forms occur with the typical species of *Tetragraptus* and extensiform *Didymograptus* characteristic of the Deepkill, or Lower Ordovician of New York.

Cotypes are figures 14, 15, 18, 19 and 21, and the paratype fragment, figure 6. The numbers for these in succession are B-2341, B-2342, B-2343, B-2344, B-2345, and B-2346.

CALLODENDROGRAPTUS STOCKYATUS
Decker, n. sp.
Figure 12

Many parts of the stipes are broad and the branching is irregular, so this species lacks the symmetrical form characteristic of those in the preceding species. The colony



EXPLANATION OF FIGS. 12–15

FIGS. *12—Callodendrograptus stockyatus* Decker, n. sp. ×4. (p. 126)
13—Mastigograptus dendrograptoides var. *curvensus* Decker, n. sp., n. var. A large colony ×4; *13a* and *13b* parts of the same colony ×8. (p. 128)
14, 15—Callodendrograptus crusherensis Decker, n. sp. Parts of two colonies ×4. (p. 126)

has a length of 24 mm. and a width of 13 mm. Branches vary up to 10 mm. in length, and in width from 0.25 to 2 mm. The bifurcation angle varies from less than 10° to over 50°. In some parts the thecae are inclined, but for the most part they are normal to the stipes. They occur 24 in 10 mm. Gonothecae occur in peculiar clusters, and doubtless some of the smaller structures are bithecae.

Remarks.—The specimen representing this species has the periderm almost completely exfoliated and exists as an indistinct impression in which it is impossible to make out all of the structure.

Holotype.—B-2347, University of Oklahoma Museum.

Genus MASTIGOGRAPTUS Reudemann, 1908

While Ruedemann (1908, p. 213) gave extensive reasons in 5½ pages for setting up this new genus, the diagnostic characteristics are included in the following statement:

> While in other graptolites distinct thecae or receptacles for the zooids are visible as denticles on the branches, the form bearing these appendages appears to possess nothing but extremely slender, uniformly thin branches with circular pits and to lack all indications of a composition of separate tubes such as are found in *Dendrograptus* and *Dictyonema*.

MASTIGOGRAPTUS DENDROGRAPTOIDES Decker, n.sp. Figures 2, 11, 17a–c

Views of both sides of the holotype are given, drawn from opposite slabs. The one on figure 2 has straight sides, central pits, and lack of thecal evidence characteristic of a *Mastigograptus*, while the one on figure 17, because of partial exfoliation, exhibits numerous thecae characteristic of *Dendrograptus*, hence the choice of the specific name.

The colony has a length of 40 mm. and a width of 20 mm. The branches vary greatly in length, and the narrow stipes are about 0.5 mm. wide. The branching is open with large interspaces. The bifurcation distances vary from 3 to 5 mm. and the bifurcation angle from 40° to 60° or more. Thecae are numerous occurring 20 to 24 in 10 mm. Higher magnification shows regular thecae, bithecae and a few large gonothecae. Part of the thecae are nearly parallel with the stipes, some are inclined, and others normal to them.

The illustration on figure 11 represents only a small part of a colony, it is a paratype.

Remarks.—This species comes from the lower part of the West Spring Creek formation from a zone equivalent to the lower Deepkill of New York, while the species described by Ruedemann are from the Upper Ordovician.

Holotype.—B-2348 figs. 17a, b, University of Oklahoma Museum. *Paratype.*—Fig. 11, B-2349.

MASTIGOGRAPTUS DENDROGRAPTOIDES var. CURVENSUS Decker, n. sp., n. var. Figures 8, 13, 20

The largest colony illustrated by figure 13, is the holotype. It is very elongated in proportion to its width. This is due to the curvature of the branches which almost universally bend distally toward the elongate axis. The colony has a length of 50 mm. and a width of 15 mm. The branches vary in length from about 7 to 10 mm. The stipes are about 0.4 mm. wide.

Thecae show only at intervals on some branches, and seem to occur 12 to 14 in 10 mm. Some elongate thecae are bunched at the ends of some of the branches, and these are doubtless reproductive gonothecae. Most of the thecae have little overlap.

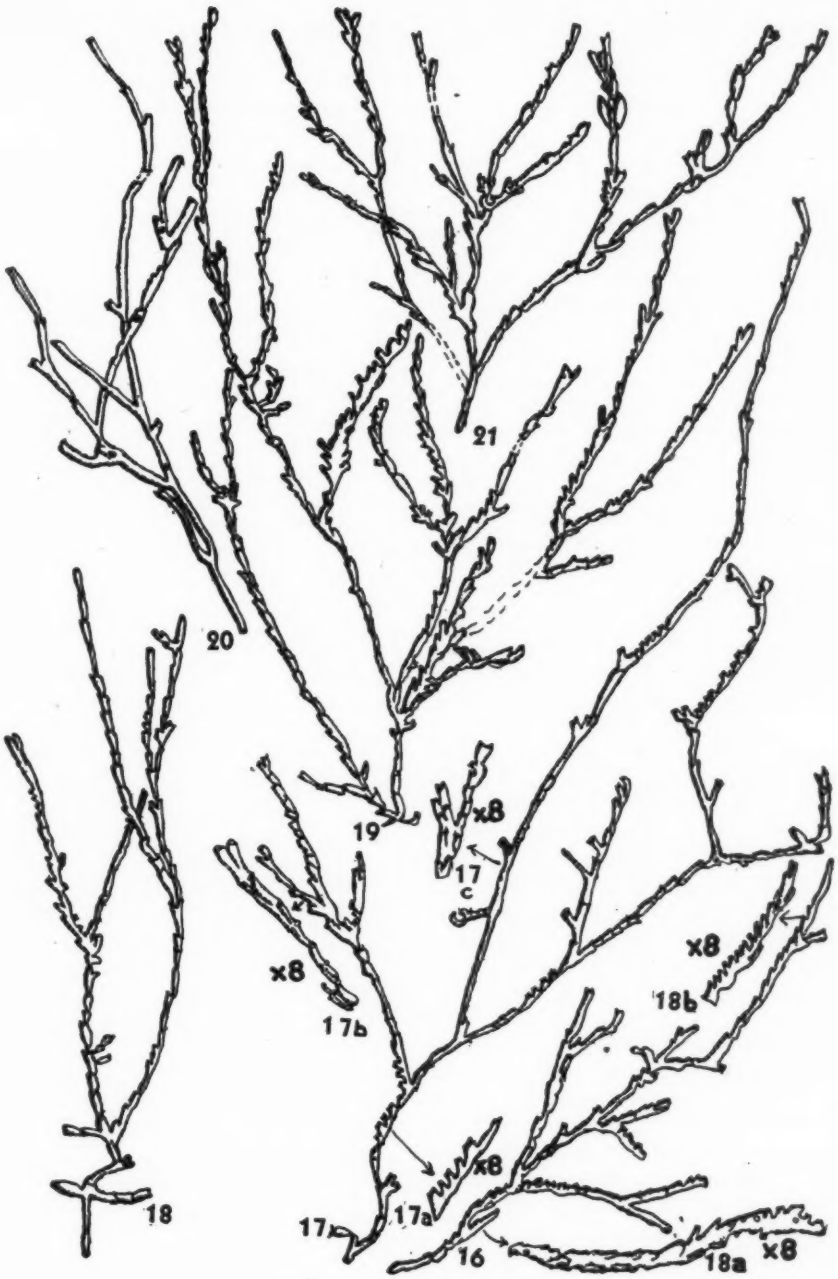
Remarks.—The holotype is the only large colony, the other two specimens are small parts of colonies.

Holotype.—figure 13, B-2350. *Paratype.*—figure 8, B-2351. *Paratype.*—figure 20, B-2352, University of Oklahoma Museum.

Genus CHAUNOGRAPTUS Hall, 1879

In an abstract Hall (1879, p. 2) described this genus first under *Dendrograptus*, then he chose *Chaunograptus novellus* (1882, p. 225) as the genotype and redescribed the genus as follows:

> Fossil occurring free in the shales or upon other fossil bodies, in slender branching fronds. Branches diverging, lax and slender with numerous branchlets, both marked by numerous cellules which are usually indicated by the appearance of abrupt expansion and contraction of



EXPLANATION OF FIGS. 16–21

FIGS. *16—Dendrograptus beachi* Decker, n. sp., ×4. (p. 128)
17—Mastigograptus dendrograptoides Decker, n. sp. Fig. 17, ×4, and 17a, 17b, 17c parts of a single colony ×8. (p. 128)
18, 19, 21—Callodendrograptus crusherensis Decker, n. sp. Figs. 18, 19, 21, ×4; 18*a* and 18*b*, ×8. (p. 126)
20—Mastigograptus dendrograptoides var. *curvensus* Decker, n. sp., n. var. ×4. (p. 128)

the branches. The angular projection of the cell aperture can be observed in many parts of the fossil.

CHAUNOGRAPTUS TRELLISATUS
Decker, n. sp.
Figures 3, 4, 7, 10

While the genotype was a tiny specimen on the shell of a brachiopod, the largest specimen seems to have developed a thick-set sparsely branched stalk on which the flexible filaments bearing the thecae twine in trellis-like fashion. These relatively large stems seem to be covered with a periderm like that on the thecae. There is a suggestion in some of the branches that they, and probably the main stalk, are composed of the filamentous stipes cemented together and covered by a periderm inclosing the imbedded filaments. This method of uniting filaments into a main stalk is characteristic of some hydrozoans.

The colony is 33.25 mm. long and 12.5 mm. wide. Thecae occur 16 to 20 in 10 mm. without overlap. They are about 0.5 mm. long and 0.25 mm. wide. Two parts of colonies shown in figures 3 and 10, are paratypes.

Remarks.—A number of other fragments were found which may represent parts broken from the large colony. If, as this might suggest, new colonies were started by fragmentation. This is similar to the reproductive hormogonia fragments in algae and the soredia in lichens. Species of *Chaunograptus* have been found from the Cambrian of Texas (Decker, 1945 p. 36) to the Lower Devonian (Decker, p. 165, 1941) of Oklahoma.

Holotype.—Figures 4 and 7; B-2352.
Paratypes.—Figures 3 and 10, B-2352, B-2354, University of Oklahoma Museum.

Observations.—The occurrence of these hydrozoan-like forms in the same zone with graptolites, suggests a close association when they were living in the ocean. As the hydrozoan-like forms have the same sort of periderm or covering as the graptolites, and as they are preserved like them, the thought occurs that the former, with their gonothecae, may represent a reproductive stage in an alternation of generations of the graptolites, similar to that which is characteristic of recent hydrozoans.

The cementing together of numerous filaments into a stem and branches, as occurs in *Chaunograptus*, is similar to the methods of stem formation in some recent hydrozoans.

Species of five genera, *Acanthograptus*, *Cactograptus*, *Chaunograptus*, *Mastigograptus*, and *Thallograptus*, first described as graptolites, have been placed by Chapman and Thomas (1936, pp. 202–209) in the group of hydrozoans which they described from the Middle Cambrian of Victoria, Australia.

All of these facts indicate a close relationship between graptolites and hydrozoans.

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JOURNAL OF PALEONTOLOGY, VOL. 21, NO. 2, PP. 131–141, 1 FIG., MARCH 1947

CONODONT ZONES IN UPPER DEVONIAN AND LOWER MISSISSIPPIAN FORMATIONS OF OHIO

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ABSTRACT—Five conodont zones are present in the formations that lie near the Devonian-Mississippian boundary in Ohio. These zones, which are named after the formations in which they occur, are: the upper Sunbury shale zone, the basal Orangeville-basal Sunbury shale zone, the basal Bedford shale zone, the Cleveland-upper Ohio shale zone, and the Huron-Lower Ohio shale zone. Evidence is presented which supports Branson and Mehl's concepts of diagnostic Devonian and Mississippian conodont genera. Correlations are made with the New Albany shale of Indiana.

INTRODUCTION

THIS paper is concerned with the conodont faunas of the following Devonian and Mississippian formations of Ohio: Sunbury, Bedford, and Ohio shales of south-central Ohio and basal Orangeville, Bedford, Cleveland, and Huron shales of northern Ohio. These formations, with the exception of the Bedford and the basal Orangeville, consist almost entirely of black shales and, as would be expected, they lack the fossils ordinarily used by stratigraphers. Instead, they contain plants, fishes, a few invertebrates, and conodonts; of these, conodonts appear to be the best suited for stratigraphic purposes. The work reported here was done as a part of the petroleum investigations that the U. S. Geological Survey is conducting in the Appalachian Basin. Its purpose was to investigate the possibility of establishing zones, based on conodonts, in the rocks that lie near the Devonian-Mississippian boundary. Not only has it been possible to do this but also evidence has been obtained which supports Branson and Mehl's concepts of diagnostic Devonian and Mississippian conodont genera.

FORMATIONS

The formations herein discussed are listed in table 1. As a unit they crop out in a narrow zone traceable northward through the central part of the State from the Ohio River to Lake Erie and from there eastward toward the Ohio-Pennsylvania State line. Conodonts were collected in the following three areas along this zone of outcrop:

1. South-central Ohio from the vicinity of Columbus southward to Waverly.
2. Northern Ohio along the Huron River between Monroeville and Milan.
3. Northern Ohio from the environs of Cleveland eastward to the Ohio-Pennsylvania State line.

TABLE 1. CORRELATION OF FORMATIONS OF NORTHERN AND SOUTH-CENTRAL OHIO

	Northern Ohio		South-central Ohio
Mississippian	Basal Orangeville shale (Sunbury sh. memb.)		Sunbury shale
	Berea sandstone		Berea sandstone
Devonian or Mississippian	Bedford shale		Bedford shale
	Cleveland shale Olmsted shale member		Upper part of Ohio shale
Devonian	Huron shale	Chagrin shale	Lower part of Ohio shale

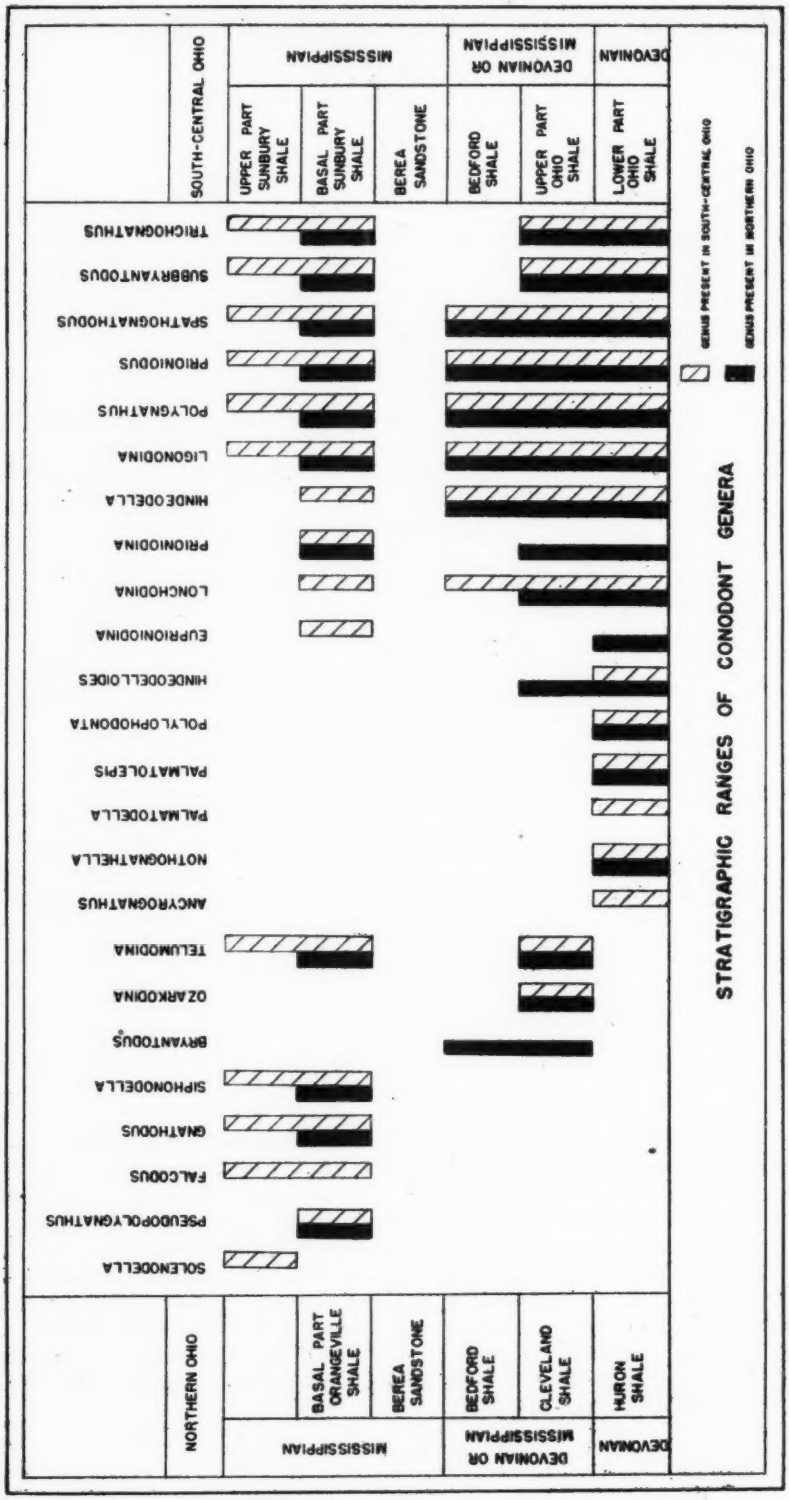
SOUTH-CENTRAL OHIO
MISSISSIPPIAN
DEVONIAN OR MISSISSIPPIAN
DEVONIAN
UPPER PART SUNBURY SHALE
BASAL PART SUNBURY SHALE
BEREA SANDSTONE
BEDFORD SHALE
UPPER PART OHIO SHALE
LOWER PART OHIO SHALE
GENUS PRESENT IN SOUTH-CENTRAL OHIO
GENUS PRESENT IN NORTHERN OHIO
STRATIGRAPHIC RANGES OF CONODONT GENERA
TRICHOGNATHUS
SUBBRYANTODUS
SPATHOGNATHODUS
PRIONIODUS
POLYGNATHUS
LIGONODINA
HINDEODELLA
PRIONIODINA
LONCHODINA
EUPRIONIODINA
HINDEODELLOIDES
POLYLOPHODONTA
PALMATOLEPIS
PALMATODELLA
NOTHOGNATHELLA
ANCYROGNATHUS
TELLUNODINA
OZARKODINA
BRYANTODUS
SIPHONODELLA
GNATHODUS
FALCODUS
PSEUDOPOLYGNATHUS
SOLENODELLA
NORTHERN OHIO
MISSISSIPPIAN
BASAL PART ORANGEVILLE SHALE
BEREA SANDSTONE
DEVONIAN OR MISSISSIPPIAN
BEDFORD SHALE
CLEVELAND SHALE
DEVONIAN
HURON SHALE

FIG. 1

The correlations shown in table 1 are, except as noted below, those previously recognized by the U. S. Geological Survey. The units designated as the upper and lower parts of the Ohio shale have been regarded by the Survey as a single formation—the Ohio shale of Upper Devonian age. Conodont evidence, however, indicates that the beds assigned to the Ohio shale are divisible into two distinct faunal zones; the lower zone is a correlative of the Huron shale and the upper, a correlative of the Cleveland shale. The conodont fauna of the lower Ohio shale has nothing in common with that of the upper part and this difference suggests that the two units may be separated by a break in sedimentation. Inasmuch as the entire exposed thickness of the Ohio shale was not examined for conodonts, the maximum thickness of each unit is not known but the lower part of the Ohio shale is over 100 feet thick in "The Narrows" north of Columbus and the upper part is at least 80 feet thick along Paint Creek south of Chillicothe. The above correlations are not new; they have been suggested by several stratigraphers on evidence other than that afforded by conodonts.

Although the Chagrin shale is shown in table 1 as grading laterally into the Huron shale, the stratigraphic relationship of the two formations is still in doubt. Prosser (1912, pp. 837–840) and Kindle (see Prosser, 1912, p. 840) were of the opinion that the Huron is the lateral equivalent of the Chagrin. G. A. Cooper (1942, p. 1764) holds a similar view and has stated that inasmuch as "the Chagrin has been shown to be the sandy shale facies of the Conewango," the Chagrin in turn would be expected to "pass laterally into a black shale as most of the other Devonian members do." Ulrich (1912), on the other hand, rejected the idea of lateral gradation and regarded the Huron shale as a younger formation. His belief (1912, p. 158) was based on the opinion that the Huron and Cleveland fish and conodont faunas are "closely and undeniably similar" and quite unlike the conodont and fish faunas "in the supposed intervening Chagrin shale." Although Ulrich placed more emphasis upon the fish than upon the conodonts, he erred in regarding the conodont faunas of the Cleveland and Huron shales as being "closely and undeniably similar." These two faunas have nothing in common and this difference, together with the fact that the Huron and the Cleveland wedge out in opposite directions, suggests that the two formations are separated by a break in sedimentation.

FAUNAL ZONES

General statement.—The literature contains many brief statements calling attention to the presence of conodonts in the formations here discussed; see, for example, Newberry (1875), Hinde (1879), Ulrich (1912), Kindle (1912), Prosser (1912), Cushing (1931), and Branson and Mehl (1934, p. 181). C. L. Cooper (1931) also has published on the conodont faunas of the black shales of Ohio. His collections came from near the top of the Ohio shale and from the Sunbury shale, northeast of Columbus. His studies (1931, p. 144) led him to conclude that the Chattanooga shale (Hardin sandstone member of the Chattanooga shale at Mount Pleasant, Tenn., and the Chattanooga shale near Huntsville, Ala.) and the Ohio shale "contain a conodont fauna similar to that found in the Sunbury shale." The writer's findings differ from Cooper's for they show that five conodont zones are present in the formations listed in table 1. Four of these zones are present in south-central Ohio as well as in the northern part of the State; the fifth and highest is present in south-central Ohio. These five zones, named after the formations in which they occur, are:

1. Upper Sunbury shale zone.
2. Basal Orangeville-basal Sunbury shale zone.
3. Basal Bedford shale zone.
4. Cleveland-upper Ohio shale zone.
5. Huron-lower Ohio shale zone.

The generic composition of each faunal zone is shown in figure 1.

Huron-lower Ohio shale zone.—The known fauna of this zone contains 16 genera and 29 species of which 12 genera and 21 species are common to both the Huron shale and the lower part of the Ohio shale. The Huron shale conodonts came from outcrops along the Huron River between Monroeville and Milan where an estimated thickness of 80 feet of beds was examined. The collections from the lower part of the Ohio shale came

TABLE 2. DISTRIBUTION OF SPECIES PRESENT IN HURON-LOWER PART OF THE OHIO SHALE ZONE

	Huron shale, northern Ohio.	Lower part of the Ohio shale, south-central Ohio.	*1. Hardin sandstone.	*2. Chattanooga shale.	*3. Upper fauna of the New Albany shale. (Upper New Albany of Campbell)	*4. Middle fauna of the New Albany shale. (Blackiston fm. of Campbell)	*5. Lower fauna of the New Albany shale. (Blocher fm. of Campbell)	*6. Grassy Creek shale.	*7. Rhinestreet shale.	*8. Genesee group.
Ancyrognathus bifurcata (Ulrich and Bassler)		X	X	X		X				
Hindeodella similis Ulrich and Bassler	X		X							
Hindeodelloides minutus Huddle	X	X				X				
Palmatodella delicatula Ulrich and Bassler		X		X		X				
Palmatolepis distorta Branson and Mehl	X	X				X		X		
Palmatolepis glabra Ulrich and Bassler	X	X	X	X		X		X		
Palmatolepis perlobata Ulrich and Bassler	X	X	X	X		X				
Palmatolepis rugosa Branson and Mehl	X	X						X		
Palmatolepis subperlobata Branson and Mehl		X								
Polylophodonta confluens (Ulrich and Bassler)	X	X	X	X		X		X		
Prioniodus alatus Hinde	X	X			X		X		X	X
Subbryantodus subangulatus (Holmes)	X	X		X						

*1. Ulrich and Bassler, 1926.
2. Holmes, 1928.
3. Huddle, 1934.
4. Huddle, 1934.
5. Huddle, 1934.
6. Branson and Mehl, 1934.
7. Ulrich and Bassler, 1926.
8. Hinde, 1879.

TABLE 3. DISTRIBUTION OF SPECIES PRESENT IN THE CLEVELAND-UPPER PART OF THE OHIO SHALE ZONE

	Cleveland shale	Upper part of the Ohio shale.	*1. Grassy Creek shale.	*2. Upper fauna of the New Albany shale. (Upper New Albany of Campbell)
Hindeodella grandis Huddle	X	X		X
Polygnathus cf. P. triangularis Branson and Mehl		X	X	
Prioniodus pronus (Huddle)	X	X		X
Spathognathodus aculeatus (Branson and Mehl)	X	X	X	
Spathognathodus inornatus (Branson and Mehl)	X	X	X	

*1. Branson and Mehl, 1934.
2. Huddle, 1934.

from outcrops immediately south of Bainbridge and from "The Narrows" at Worthington, north of Columbus. At "The Narrows" collections were made at intervals throughout 110 feet of section.

Approximately half of the species of this zone are regarded as new. Some, including *Ancyrognathus bifurcata*, *Palmatolepsis rugosa*, and *Palmatodella delicatula*, are known from only a few specimens; others, including *Palmatolepis perlobata*, *P. glabra*, *Polylophodonta confluens*, and several species of *Hindeodella* are represented by numerous specimens. *Icriodus*, one of Branson and Mehl's diagnostic Devonian genera, has not been found by the writer but Branson and Mehl (1934, pp. 181, 183) have reported it from the basal Huron shale near Bellefontaine, Ohio. The known fauna of this zone, therefore, lacks only one of Branson and Mehl's diagnostic Devonian genera, i.e., *Ancyrodella*. None of the species of the Huron-lower Ohio shale zone has been recognized in the overlying Cleveland-upper Ohio shale zone but 12 species have been identified with previously described forms. The presence of these 12 indicates that the fauna is most like that of the Grassy Creek shale of Missouri, the Chattanooga shale near Huntsville, Ala., the Hardin sandstone member of the Chattanooga shale at Mount Pleasant, Tenn., and the middle fauna of the New Albany shale of southern Indiana (Blackiston formation of Campbell). The distribution of these 12 species is shown in table 2.

Cleveland-upper Ohio shale zone.—This faunal zone contains specimens that belong to 13 genera and 24 species. Ten of the genera and 15 of the species are present in both the Cleveland shale and the upper part of the Ohio shale. The Cleveland shale is reported to be approximately 100 feet thick immediately west of Cleveland, Ohio, where, at the base, it includes the Olmsted shale member. The Olmsted is confined to this area but the Cleveland shale above the Olmsted member is more widespread; it wedges out to the east and disappears in the vicinity of the Grand River valley. Collections were made from the Cleveland shale above the Olmsted member at the following localities: Along Rocky River at Olmsted, Chippewa Creek at Brecksville, Brandywine Creek at Brandywine, Tinkers Creek near Bedford, Euclid Creek at Euclid, Stebbins Gulch near Chardon, and Indian Creek near Windsor. The upper 25 feet of the Olmsted shale member were also examined in the vicinity of Olmsted, Ohio. This upper part contains conodonts identical with those present in the overlying beds of the Cleveland shale. The lower parts of the Olmsted shale were not investigated. Collections from the upper part of the Ohio shale came from outcrops in the immediate vicinity of Chillicothe, especially along Paint Creek where 80 feet of the shale were examined, and from an outcrop on Rocky Fork, northeast of Columbus.

The Cleveland-upper Ohio shale zone is easily recognized for it is dominated by the compound barlike and bladelike types of conodonts. In fact, only a few platelike conodonts have been found and all of them belong to three species of *Polygnathus*. The faunal composition is, therefore, in sharp contrast with that of the underlying Huron-lower Ohio shale zone in which platelike types, such as *Palmatolepis* and *Polylophodonta*, are very abundant. Most specimens in the Cleveland-upper Ohio shale zone belong to the genera *Spathognathodus*, *Hindeodella*, and *Prioniodus*. The species *Spathognathodus aculeatus*, *S. inornatus*, and *Hindeodella grandis* are especially abundant. Most of the species in this zone are new; only five have been identified or compared with previously described forms. They are listed in Table 3.

Bedford shale zone.—Conodonts are not abundant in this zone. The known fauna consists of only 7 genera and 16 species of which 5 genera and 5 species have been found in both northern and south-central Ohio. Collections were made from outcrops in the ravines along Paint Creek south of Chillicothe and from exposures along Euclid and Brandywine Creeks near Cleveland. These conodonts were collected from the basal few feet of the formation where they are associated with macrofossils in a zone that occurs "very close to the Devonian-Mississippian boundary" (G. A. Cooper, 1942, p. 1746). The conodont fauna, with the exception of a few polygnathids, consists entirely of bladelike and barlike types. Fortunately, the most abundant type is

quite distinctive. It is a new species of *Spathognathodus* that possesses a single hornlike process on the inner side of the blade immediately anterior to the pulp-cavity. This spathognathodid has not been found in any other fauna zone. A few specimens of *Spathognathodus inornatus* and one of *S. aciedentatus* are present. The former is quite common in the Cleveland-upper Ohio shale zone and the latter is found in the overlying basal Sunbury shale zone.

ville, Tinkers Creek at Bedford, Stebbins Gulch near Chardon, Wilson Mills in southwestern Ashtabula County, and from Walnut Creek at Courtland which is only 9 miles from the Ohio-Pennsylvania State line.

The conodonts of this zone are found in the basal 2 to 3 inches of the shale. It is an easily recognized fauna for it is the first above the Huron-lower Ohio shale zone in which the platelike types of conodonts are

TABLE 4. DISTRIBUTION OF SPECIES PRESENT IN THE BASAL ORANGEVILLE-BASAL SUNBURY SHALE ZONE

	Basal Orangeville shale.	Basal Sunbury shale.	*1. Upper fauna of the New Albany shale. (upper New Albany of Campbell)	*2. Bushberg sandstone.	*3. Hannibal shale.
Polygnathus communis Branson and Mehl	X	X	X	X	X
Polygnathus sulcata Huddle		X	X		
Pseudopolygnathus prima Branson and Mehl	X	X		X	X
Siphonodella plana (Huddle)	X	?	X		
Spathognathodus aciedentatus (E. B. Branson)	X	X	X	X	X

*1. Huddle, 1934.
2. Branson and Mehl, 1934.
3. E. B. Branson, 1934.

Basal Orangeville-basal Sunbury shale zone.—This faunal zone contains 15 genera and 24 species. Eleven of the genera and 12 of the species are present in both northern and south-central Ohio. Collections were made from the basal Sunbury shale at the following localities: Near Waverly, near Chillicothe, along Ralston Run at Yankeetown, at Turkey Run northeast of Circleville, and along Rocky Fork northeast of Columbus. Those from the basal Orangeville came from Chippewa Creek at Brecks-

well represented. Also, specimens belonging to some of Branson and Mehl's diagnostic Mississippian conodont genera make their first appearance in this zone. The following species dominate the fauna: *Gnathodus*, n. sp. A, *Pseudopolygnathus prima*, *Polygnathus communis*, and *Spathognathodus aciedentatus*. In addition, *Siphonodella plana* is present in northern Ohio in the vicinity of Cleveland. The new specimens that have been identified specifically also are found in the upper New Albany unit of Campbell, the Bush-

berg sandstone member of the Sulphur Springs formation, and the Hannibal shale. These species are listed in Table 4.

Upper Sunbury shale zone.—At two localities in south-central Ohio, conodonts were collected in the upper part of the Sunbury shale. One locality is on Ralston Run at Yankeetown, 7½ miles southwest of Chillicothe. There, the conodont zone is approximately 15 feet above the Berea-Bedford contact. The other locality is on Duncan Run at Harlem, 16 miles northeast of Columbus where the fauna is present about 22 feet above the base of the formation.

The known fauna consists of 11 genera and 16 species. It differs from that in the basal layers of the Orangeville and Sunbury shales in containing several distinctive species and in apparently lacking specimens of *Pseudopolygnathus prima* and *Siphonodella plana*. *Gnathodus* n. sp. A, and *Polygnathus communis* range up into this zone from the basal Sunbury. Other species are *Falcodus* n. sp. A, *Siphonodella duplicata*, *Siphonodella quadruplicata*, and *Solenodella lacerata*. *Polygnathus communis* and the two species of *Siphonodella* mentioned above dominate the fauna; *Solenodella*, one of Branson and Mehl's diagnostic Mississippian genera, has not been found below this faunal zone. The four specifically identified species are also present in the Bushberg sandstone member of the Sulphur Springs formation, the Hannibal shale, and the upper New Albany unit of Campbell.

DIAGNOSTIC CONODONT GENERA

In addition to establishing the above named faunal zones, the evidence at hand suggests that Branson and Mehl's concepts of diagnostic conodont genera are, in the main, correct. (See Branson and Mehl, 1934, pp. 181–184; 1934a, pp. 265–267; 1938, p. 157; 1940). Summarized, Branson and Mehl's thesis is that the genera *Ancyrodella*, *Ancyrognathus*, *Icriodus*, *Palmatolepis*, and *Polylophodonta* are confined to beds of Devonian age; that the genera *Pinacognathodus*, *Pseudopolygnathus*, *Siphonodella*, and *Solenodella* are confined to beds of Mississippian age; and that the age of a faunal lot which contains both sets of genera is Mississippian, the Devonian specimens, in it, being reworked material. Two of Branson and Mehl's Devonian genera, *Icriodus* and *Ancyrodella*, and one of their Mississippian genera, *Pinacognathodus*, have not been found in the collections studied by the writer. Of the remaining, the Devonian genera are confined to the Huron-lower Ohio shale zone. The Mississippian genera make their first appearance either in the basal Orangeville-basal Sunbury shale zone or in the upper Sunbury shale zone. Between the formations that contain these two sets of genera—in the Basal Bedford shale—is a zone of macrofossils which, according to G. A. Cooper (1942, p. 1746) occurs "very close to the Devonian-Mississippian boundary." This evidence, as well as that which indicates that the Chagrin shale grades laterally into the Huron shale, strongly suggests that in the main Branson and Mehl's concepts are valid. It should be pointed out, however, that the mere presence of the diagnostic Devonian genera in a faunal lot which lacks the diagnostic Mississippian genera does not necessarily indicate a Devonian age for the collection because in some formations (e.g. stratigraphic equivalents of the Cleveland shale and the Bedford shale) the Devonian genera could be present as reworked material.

Correlations with the New Albany shale of Indiana.—The Upper Devonian and lower Mississippian formations of Ohio are part of a zone of rocks that extends over much of the interior of the United States and northward into Canada. Much work has been done on these rocks but, in many areas, the details of stratigraphy are not well known; as a result, conflicting views are held regarding the correlation of the beds in one area with those in another or with the formations of the so-called standard Devonian and Mississippian sections [See G. A. Cooper (1942, pp. 1736–1740) and Ellison (1946, pp. 102–107)]. A recent stratigraphic paper by Campbell (1946) treats of the New Albany shale of Indiana and its correlates. It is a valuable contribution to the knowledge of the stratigraphy of the black shales. However, Campbell's correlations of some of the subdivisions of the New Albany shale of Indiana with the Upper Devonian and lower Mississippian formations of Ohio are

TABLE 5. THE NEW ALBANY SHALE OF INDIANA AND ITS CORRELATES IN OHIO AS PROPOSED BY CAMPBELL, 1946

		Indiana		Ohio
Mississippian	Lower	New Albany shale	Upper New Albany Henryville formation Underwood formation Sanderson formation Falling Run member	Sunbury shale Bedford shale Cleveland shale
Devonian	Upper		Blackiston formation Upper Blackiston member Lower Blackiston member	Olmsted shale Huron shale
	Middle		Blocher formation	

not entirely in accord with the findings reported in the present paper. The following paragraphs point out these differences.

Campbell's divisions of the New Albany shale of Indiana and his correlation of these units with the formations of Ohio are listed in table 5; the writer's correlations of these same beds are presented in table 6.

For the most part, Campbell's correlations of the New Albany shale of Indiana with the formations in Ohio are not based on conodonts. Instead, with the exception of the Huron shale, they are based upon (1) a correlation of the divisions of the New Albany shale of Indiana with beds in eastern Kentucky that are the southern extensions of the Upper Devonian and lower Mississippian formations of Ohio; (2) the lithologic and stratigraphic features of the rocks; (3) the presence of *Lingula melie, Orbiculoidea herzeri,* and *Spathiocaris williamsi* in the Cleveland shale; and (4) the correlation of the macrofossils of the Underwood formation with those in the basal Bedford shale.

By way of contrast, Campbell's major divisions of the New Albany shale are based

TABLE 6. THE NEW ALBANY SHALE OF INDIANA AND ITS CORRELATES IN OHIO AS PROPOSED IN PRESENT PAPER

			Indiana	Northern Ohio	South-central Ohio
Mississippian	Lower	New Albany shale	Upper New Albany Henryville formation Underwood formation Sanderson formation Falling Run member	Basal Orangeville shale (Sunbury shale member) Berea sandstone	Sunbury shale Berea sandstone
Devonian or Mississippian				Bedford shale Cleveland shale Olmsted shale member	Bedford shale Upper part of Ohio shale
Devonian	Upper		Blackiston formation Upper Blackiston member Lower Blackiston member	Huron shale	Lower part of Ohio shale
	Middle		Blocher formation		

on conodonts. He recognizes three distinct faunas. The lowest is confined to the Middle Devonian beds which he has named the Blocher formation. It is older than the fauna found in any of the formations from Ohio considered here. The intermediate fauna ranges throughout the Upper Devonian beds which Campbell has named the Blackiston formation and the highest fauna is found in his upper New Albany unit of Mississippian age. The Blackiston contains Upper Devonian species of plants and animals including all of the diagnostic Devonian conodont genera of Branson and Mehl. These genera, moreover, range throughout the entire formation and, with the exception of one species of *Palmatolepis*, are not found in the overlying beds of the upper New Albany unit. As *Barroisella* is confined to the lower part of the Blackiston above which there is a hiatus followed by a change in lithology, Campbell divided the Blackiston formation into upper and lower members. He correlated the lower member with the Huron shale and the upper, with the Olmsted member of the Cleveland shale. The conodont fauna of the Huron shale is discussed previously in this paper. It contains fewer species than are present in the Blackiston but both faunas possess identical species as well as a similar set of genera—including all but one of Branson and Mehl's diagnostic Devonian genera. Because of these similarities the Huron shale is regarded as a correlate of the Blackiston formation but it is not possible from the information now on hand to determine whether the Huron should be correlated with all or with only a part of the Blackiston.

The Olmsted member of the Cleveland shale, however cannot be correlated with the upper member of the Blackiston formation. Campbell's (1946, p. 877) reasons for this correlation are stated as follows. "The evidence for the age of the upper Blackiston [Olmsted] in Ohio, as in Kentucky, depends on its stratigraphic relations with the lower Blackiston [Huron] and Sanderson [Cleveland], and the age [is] determined by conodonts in Indiana." The age of the Olmsted shale, however, does not depend upon stratigraphic relationships nor upon the conodonts in Indiana, but rather, upon its own relations and its own conodont fauna. The Olmsted fauna is identical with that of the Cleveland shale and is quite distinct from that of Campbell's Blackiston formation. The conodonts collected by the writer are from the upper 25 feet of the Olmsted and are from outcrops in the vicinity of Olmsted, Ohio, including those immediately downstream from the junction of the east and west branches of the Rocky River. Campbell (1946, p. 876) regarded this locality as being a good exposure of the upper Blackiston. Although no conodonts were collected from the lower parts of the Olmsted member, the writer prefers, until evidence to the contrary is submitted, to regard those beds as also being an integral part of the Cleveland shale.

The upper New Albany unit consists of three formations—the Sanderson, Underwood, and Henryville—which are bound together by a single conodont fauna. This fauna contains a new set of conodonts, including some of the diagnostic Mississippian genera of Branson and Mehl, and differs radically from the fauna present in Campbell's Blackiston formation. Campbell (1946, p. 903) based the age of his upper New Albany unit on these conodonts. He wrote "the Mississippian stamp of the conodont genera has been the deciding factor in determining the Mississippian age of the upper New Albany." He (p. 877) correlated that part of the Cleveland shale that lies above the Olmsted member with his Sanderson formation. This correlation is based upon the stratigraphic position of the Cleveland beneath the Bedford, and upon the presence of *Lingula melie*, *Orbiculoidea herzeri*, and *Spathiocaris williamsi* in the Cleveland fauna. According to Campbell all three of these species "occur in the Sanderson in Kentucky and Indiana and [not only] verify the extension of the Sanderson into Ohio [but also verify] . . . its Mississippian age." However, as far as the conodont evidence is concerned, the Cleveland shale above the Olmsted member can no more be correlated with the Sanderson formation than can the Olmsted with the upper Blackiston. The fauna of the Cleveland shale, and the upper 25 feet of the Olmsted member, is

discussed previously in this paper. It consists almost entirely of compound bladelike and barlike conodonts dominated by the species *Spathognathodus aculeatus*, *Spathognathodus inornatus*, and *Hindeodella grandis* and contains none of the diagnostic Devonian or Mississippian conodont genera of Branson and Mehl. These facts show that the Olmsted and the Cleveland above the Olmsted should be regarded as parts of a single formation and refute Campbell's belief that the Devonian-lower Carboniferous boundary in Ohio should be drawn between them. The age of the formation is in doubt but it is younger than that of the Blackiston and older than that of the Sanderson.

Campbell's Underwood formation and its suggested correlatives (the Glen Park of Missouri, the Hamburg oolite of Illinois, and the Bedford shale of Ohio) are of special interest. G. A. Cooper (1942, p. 1762) has suggested that the Glen Park, which has long been correlated with the Hamburg, may also be correlated with the Bedford and with the shale at the top of the New Albany which contains a marine fauna, i.e., Underwood). The age of these formations he regards (p. 1762) as doubtful because their fossils could serve equally well as the oldest fauna of the Mississippian or the youngest of the Devonian. Campbell, on the other hand, placed the above named formations in the Mississippian because one of them—the Underwood—overlies the Sanderson, in which a Mississippian conodont fauna is present. However, on the evidence afforded by conodonts, the Underwood cannot be correlated with the Bedford shale. The conodont fauna of the Bedford shale, though small and poorly preserved, is distinguished by the following features: it contains a distinctive species of *Spathognathodus;* it is composed almost entirely of bladelike and barlike conodonts; and it lacks both the diagnostic Devonian and Mississippian conodont genera of Branson and Mehl. Therefore, on the basis of conodonts, the Bedford shale is older than the Sanderson formation and is here regarded as Devonian or Mississippian in age whereas the Underwood, by reason of its stratigraphic position above the Sanderson, is Mississippian. The Glen Park formation, on the other hand, may be older than the Bedford shale. Branson (1938, p. 179) has reported that Grassy Creek conodonts are present in the Glen Park, and my investigations confirm his observations. The following easily recognized Grassy Creek conodonts have been identified in a collection from the type locality of the Glen Park: *Palmatolepis distorta*, *P. glabra*, *P. gracilis*, *Polymorphodonta confluens* and *Spathognathodus disparilis*. *S. aculeatus*, a species which is very abundant in the Cleveland-upper Ohio shale zone, is present, as is *Phragmodus* sp. The latter genus is Ordovician and it is obvious that these specimens have been reworked into the Glen Park formation; as for the Grassy Creek conodonts, it is possible that they also are remanié. My collections from the Hamburg oolite have not yielded conodonts. In the light of the conodont evidence, it will be necessary to restudy the macrofossils of the Underwood, Bedford, Hamburg, and Glen Park before their relationships are known.

Of all the formations investigated in Ohio, only the Sunbury and the Orangeville shales have conodont faunas similar to that found in the upper New Albany unit. All these formations contain Mississippian types of conodonts including some of the diagnostic Mississippian genera of Branson and Mehl. Campbell (1946, p. 875) suggested that the Sunbury shale may be equivalent to his Henryville formation, but the writer, for the present, prefers to regard the Sunbury merely as a correlate of the upper New Albany unit. No conodonts have been found in the Mississippian Berea sandstone of Ohio; this formation underlies the Sunbury and may also correlate with a part of the upper New Albany.

CONCLUSIONS

In summary, the writer concludes that:

1. Five distinct conodont zones are present in the formations that lie near the Devonian-Mississippian boundary in Ohio.

2. The Ohio shale contains two distinct conodont zones; the lower is equivalent to the Huron shale and the upper is equivalent to the Cleveland shale.

3. Branson and Mehl's diagnostic Devonian and Mississippian conodont genera are, in the main, valid indicators of geologic age.

4. Campbell's Blackiston formation of Indiana is equivalent to the Huron shale

and his upper New Albany unit is a correlate of the Sunbury shale. The Bedford shale, the Cleveland shale, and the Olmsted shale member of the Cleveland shale are younger than Campbell's Blackiston formation but older than his Sanderson formation.

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JOURNAL OF PALEONTOLOGY, VOL. 21, NO. 2, PP. 142–146, 1 FIG., March 1947

LOWER PENNSYLVANIAN STRATA OF THE LLANO REGION—SUMMARY OF CLASSIFICATION

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ABSTRACT—The latest classification of the lower Pennsylvanian rocks of the Llano Uplift of central Texas is summarized, and the common or characteristic fossils from the different stratigraphic units are listed. Also, the general lithology of the larger stratigraphic units is discussed.

INTRODUCTION

THE lower Pennsylvanian strata of the Llano region present more difficulties in classification than the upper ones because they are less clearly differentiated, and because the fossils in them are less well known. The latest classification (Fig. 1) is as follows:

The differentiation of these strata into members and formations like that of the upper portion of the Pennsylvanian section is based on lithology and paleontology.

DESCRIPTION OF FORMATIONS AND MEMBERS

Sloan formation.—The Sloan formation is

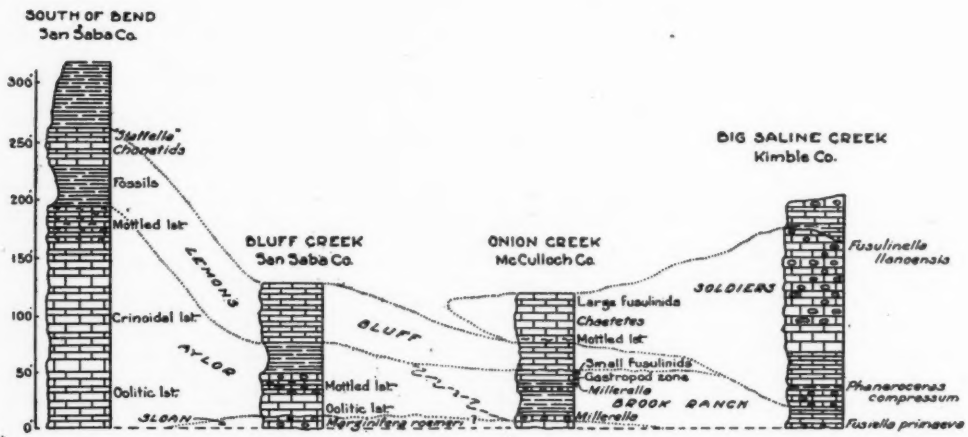

FIG. 1.—Stratigraphic sections of Pennsylvanian formations in the Llano region showing correlation of the formations and members.

Group	Formation	Members east of Cavern Ridge	Members west of Cavern Ridge
Bend = Atoka	Smithwick	Siltstone facies Shale facies	Absent Absent (?)
	Big Saline	Brister Lemons Bluff Aylor Gibbons	Soldiers Lemons Bluff* Brook Ranch Gibbons
Morrow = Upper Morrow	Sloan	Present	Absent (?)

* Absent southwest of Brook Ranch in McCulloch County.

a thin-bedded, crypto-crystalline, and dense black limestone separated by thin partings of shale. The total thickness of the Sloan is about 50 feet. In many places, however, it is only a few feet thick and may thin out to zero. The fossils are numerous and fairly well preserved. The commonest and most characteristic ones are:

Dictyoclostus morrowensis (Mather)
Marginifera roemeri (Girty)
Linoproductus nodosus (Newberry)
Phaneroceras nolinense (Cox)

As far as known now, the only fusulinids found in the Sloan are the forms of *Millerella* reported below by Thompson from the type section. Other common fossils are as follows:

Rhynchopora illinoisensis (Worthen)
Horridonia globosa (Mather)
Juresania wilberana (McChesney)
Paeckelmannia sp.
Ethelocrinus texasensis (Moore and Plummer)
Cibolocrinus punctatus (Moore and Plummer)
Composita ozarkana (Mather)

Big Saline formation.—The Big Saline formation is made up almost wholly of limestone. It consists of four members east of Cavern Ridge, and two additional members west of the ridge. Each member is recognized by characteristic texture, color, grain size, and chemical content, and by certain characteristic fossils, although in many cases the fossils of the different members are much alike. A marked unconformity separates the Sloan formation from the Big Saline, and in many places the entire thickness of the Sloan was removed by erosion before the Big Saline strata were deposited. The Big Saline consists of the following members:

MEMBERS OF BIG SALINE FORMATION EAST OF CAVERN RIDGE

Name	Lithology	Characteristic fossils
Brister limestone	Thick-bedded	*Profusulinella marblensis*, Thompson n. sp. Large *Chaetetes*
Lemons Bluff spiculite	Thin-bedded spiculite	*Chonetes dominus* (King) *Staffella expansa*, Thompson n. sp. *Nankinella plummeri*, Thompson n. sp. *Spirifer opimus* Hall *Branneroceras branneri* (Smith)
Aylor oölite	White, pure, oölitic, medium to thick beds	
Gibbons conglomerate	Coarse pebble conglomerate, in many cases fossiliferous	Water-worn spirifers and productids

MEMBERS OF BIG SALINE FORMATION WEST OF THE CAVERN RIDGE

Name	Lithology	Characteristic fossils
Soldiers limestone	Massive, coarsely crystalline	*Fusulinella llanoensis* (Thomas) Large *Chaetetes*
Lemons Bluff spiculite	Same as east of ridge	Many same as east of ridge
Brook Ranch limestone	Black, hard subcrystalline, very cherty limestone	*Neospirifer cameratus* (Morton) Turritellid-like gastropods, *Profusulinella* n. spp.
Gibbons conglomerate	Same as east of ridge	Water-worn bellerophons

Gibbons conglomerate member.—The lower member of the Big Saline is named for an

[1] The term "Big Saline limestone" as here used east of Cavern Ridge includes the type section of the Marble Falls limestone and other sections of the Marble Falls limestone east of Cavern Ridge discussed by Thompson in the following paper.

excellent exposure along the new Brady-San Saba highway on the Gibbons ranch. The conglomerate consists of a layer of chert and limestone pebbles averaging ½ inch in diameter and having a thickness of 2 inches to 3 feet. The average thickness is about 6 inches. The layer is absent in many places and in some places the line of demarcation between the Gibbons conglomerate and the overlying member is not prominent.

Aylor oölite member.—The Aylor oölitic member consists of light gray crystalline limestone and oölite which occurs between the Gibbons conglomerate and Lemons Bluff spiculite member. In many places the oölite is interbedded with and overlain by coarsely crystalline crinoidal limestone. In the vicinity of the Colorado River the oölite increases in thickness to form a lentil five miles long and 10 to 100 feet thick. Its greatest thickness is in the middle of the Colorado River syncline. Fossils in the oölite are not plentiful and they have not been studied in detail. Fusulinids of the genus *Millerella* are abundant in the type section on Aylor Bluff in McAnnelly's Bend of Colorado River.

Lemons Bluff spiculite member.—The Lemons Bluff spiculite member of the Big Saline formation is quite distinctive because of the high sponge spicule content and because it occurs in beds one to two feet thick, separated by thin partings so that its cliffs resemble masonry walls. It is 20 to 60 feet thick and made up of 20% to 50% of sponge spicules set in a dense ground mass of dark gray subcrystalline limestone. Strata with the Lemons Bluff type lithology have been traced from Lampasas on the east to near Brady on the west. It may be identified easily by its spicule content. On weathering the calcium carbonate dissolves, leaving a mass of interlacing minute spicules that are so light in weight that the fragments are referred to by the ranchmen as cotton rock. The rock may also be recognized by dissolving fragments in acid and observing the insoluble residue made up of a mass of minute spicules and by the fact that fragments will melt in an electric furnace or blow torch flame below 2,000°F. Other layers of the lower Pennsylvanian limestones do not melt, but upon heating change to calcium oxide with loss of carbon dioxide.

The Lemons Bluff spiculite member is quite fossiliferous. The most characteristic fossils are:

Chonetes dominus (King) (common)
Brannerоceras branneri (Smith) (rare)
Spirifer opimus Hall (common)
Phaneroceras compressum (Hyatt) (common)
Paralegoceras texanum (Shumard) (rare)

The latter three forms occur also in the Smithwick, but the specimens in the Smithwick are much thinner shelled and more compressed.

Other common fossils in the Lemons Bluff member are as follows:

Neospirifer goreii (Mather)
Punctospirifer transversus (McChesney)
Orthotetes kansasensis (McChesney)
Wellerella utah (Marcou)
Spirifer matheri Dunbar and Condra
Rhipidomella sp.

Near the top of the Lemons Bluff spiculite member east of Cavern Ridge there is a zone containing abundant fusulinids of the genera *Millerella*, *Staffella*, *Nankinella*, and *Eoschubertella*, and in places numerous, poorly preserved gastropods, of which *Pharkidonotus* and *Straparolus* are most common.

Brister limestone member.—The Brister limestone member overlies the Lemons Bluff beds in a few places east of the Cavern Ridge and is in turn covered by the Smithwick shale. In most places, however, the Brister limestone is missing and the shale rests directly upon the Lemons Bluff beds. The Brister consists of medium to thick-bedded, coarsely crystalline, crinoidal limestone made up of conglomerate-like nodules and crinoidal detritus with very irregular bedding planes and other characteristics which suggest a reef-like origin. The total thickness of the Brister is 50 to 75 feet. The fossils are similar to those in the Lemons Bluff below, but they are less numerous, less well preserved, and include a larger proportion of corals and productids. *Chaetetes* colonies and large echinoid spines are common. Thompson reports *Profusulinella marblensis* n. sp., *Pseudostaffella* cf. *P. needhami* Thompson, *Eoschubertella texana* n. sp., *Nankinella* sp., *Staffella expansa* n. sp., and numerous *Millerella* in the Brister member at Rough Creek and at McAnnelly's Bend.

Brook Ranch limestone member.—The Brook Ranch beds occur on the west side of Cavern Ridge. They differ so distinctly

from the Aylor oölite in appearance, in their chert content, and in the abundance of larger fusulinids as to constitute a separate lithologic and stratigraphic unit. The Brook Ranch is typically a very hard subcrystalline dark gray, nearly black, cherty limestone. The total thickness of the beds is 15 to 25 feet. The most characteristic feature is the presence of great numbers of fusulinids referable to *Profusulinella*. Near the top of the Brook Ranch member in many places there is a zone of small turritellid gastropods which in most cases are silicified so that they can be dissolved out of the limestone and collected in quite large numbers and variety. A large unnamed euomphalid is another characteristic fossil of this member.

Soldiers limestone member.—The upper member west of the Cavern Ridge, known as the Soldiers limestone member, occurs above the Brooks Ranch member and, near Cavern Ridge, above beds with the same lithology as that of the Lemons Bluff spiculite at Lemons Bluff. Its stratigraphic position just west of Cavern Ridge above beds of Lemons Bluff lithology suggests the Soldiers member has a stratigraphic position similar to that of the Brister member east of the ridge. However, the Soldiers member differs from the Brister member in lithology, in fossil content, in mode of deposition, in thickness, and in lateral development. The Soldiers member consists of light gray, coarsely crystalline, massively bedded, crinoidal, fossiliferous limestone. It is thinnest south of Rochelle, thickens westward, so that at Brady it is 75 feet thick, and at Big Saline Creek in Kimble County nearly 200 feet. The most characteristic feature of the member is its numerous fusulinids belonging to the genus *Fusulinella* that occur in nearly every layer. It also contains numerous corals, especially many *Chaetetes* and other fossils as shown in the following list of fossils of the Soldiers limestone member:

Fusulinella llanoensis (Thomas) and *F.* spp.
Spirifer rockymontanus Marcou
Neospirifer cameratus (Morton)
N. goreii (Mather)
Schizophoria resupinoides (Cox)
Cleiothyridina orbicularis (McChesney)
Linoproductus welleri (Mather)
Chonetina choteauensis (Mather)
Dictyoclostus inflatus var. *coloradoensis* (Girty)
Squamularia perplexa (McChesney)
Composita ovata (Mather)
Allorisma costatum (Meek and Worthen)
Cancrinella sampsoni (Weller)
Pronorites llanoensis Plummer and Scott
Burtonia sp.

The fossils indicate that the Soldiers limestone member is younger than the Lemons Bluff, and it may prove to be as young as the basal Smithwick. No Smithwick shale has been found on the outcrop above the Soldiers member except possibly at a few places like Honey Creek southwest of Mason. On Honey Creek southwest of Mason the upper part of the Soldiers limestone apparently is replaced by Smithwick-like shale. On the other hand, the Soldiers beds do not contain any typical Smithwick fossils except the long range forms.

Smithwick formation.—The Smithwick formation is black, fissile, highly siliceous shale containing in its upper portion layers and lentils of fine, hard, firmly cemented siltstone. It is thickest in the synclinal areas and thins by loss of lower beds as it overlaps over anticlines where its base is marked by a thin pebble conglomerate. It appears, therefore, that some deformation took place in central Texas at the end of the Big Saline epoch, and that the Smithwick sediments filled the depressions and overlapped the elevations. The thickness of the Smithwick ranges from 0 to 600 feet with an average of about 400 feet.

The lower Smithwick strata carry a rather rich fauna. The upper Smithwick in most places is unfossiliferous. The following list represents the most typical forms:

Straparolus savagei (Knight)
Nuculopsis ventricosa (Hall)
Crurithyris planoconvexa (Shumard)
Daraelites (*Boesites*) *scotti* (Miller and Furnish)
Nuculoceras smithwickense (Plummer and Scott)
Leda arata (Hall)
Paeckelmannia derelecta (King)
Cumminsia aplata (Cummins)
Gastrioceras occidentale (Miller and Faber)
G. smithwickense Plummer and Scott
Cleiothyridina sublamellosa (Hall)
Pharkidonotus cf. *P. percarinatus* (Conrad)

Strawn-Smithwick contact.—A prominent unconformity occurs at the top of the Smithwick in central Texas. The Strawn strata were deposited on the deformed and somewhat eroded Smithwick beds. The uncon-

formity represents a long hiatus because not only is the Smithwick fauna in every way unlike the Strawn fauna, the Smithwick is much more compact on settling, and wide-spread deformation took place before the Strawn strata were laid down. In many places the deformation is so extensive that the Strawn overlaps the entire lower Pennsylvanian section resting on the Ordovician limestones. In other places, the deformation between the two groups of beds is so extensive that the Lower Pennsylvanian beds dip east and the Strawn strata dip west. In fact, this Strawn-Smithwick unconformity is the most pronounced in a region replete with unconformities.

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STRATIGRAPHY AND FUSULINIDS OF PRE-DESMOINESIAN PENNSYLVANIAN ROCKS, LLANO UPLIFT, TEXAS[1]

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ABSTRACT—Fusulinids from the eastern side of the Llano Uplift indicate that the Sloan limestone member of the Marble Falls limestone is Morrowan in age. Fusulinid faunas demonstrate that the middle and upper parts of the Marble Falls limestone on the eastern side of the Llano Uplift are post-Morrowan in age but are older stratigraphically than the Big Saline limestone on the western side of the uplift. Seven species of fusulinids from the middle and upper parts of the Marble Falls limestone are described and illustrated as *Nankinella plummeri*, n. sp.; *Staffella expansa*, n. sp.; *S.* sp.; *Eoschubertella texana*, n. sp.; *E.* spp.; *Pseudostaffella* aff. *P. needhami* Thompson; and *Profusulinella marblensis*, n. sp.

INTRODUCTION AND ACKNOWLEDGMENTS

THE pre-Desmoinesian Pennsylvanian rocks exposed in the eastern part of the Llano Uplift of central Texas consist of two major lithologic units, the lower of which is largely limestone and the upper largely shale. These units are generally referred to as the Marble Falls limestone below and the Smithwick shale above. The type localities of both are on the southeastern margin of the Llano Uplift; that of the Marble Falls limestone at the town of Marble Falls and that of the Smithwick shale at the old town of Smithwick, about 6 miles east by southeast of Marble Falls.

The pre-Desmoinesian Pennsylvanian rocks exposed in the western part of the uplift also consist of a lower limestone unit and, in some localities, an overlying thick shale. The limestone is named the Big Saline limestone and the overlying shale is here referred to the Smithwick. The type locality of the Big Saline is at Pfluger Bluff on Llano River south of London.

Considerable question has long existed as to the stratigraphic correlation of the type section of the Marble Falls with other American pre-Desmoinesian rocks. The pre-Desmoinesian Pennsylvanian rocks of the Llano Uplift are of considerable importance because the type locality of both the Bendian series and the Lampasan series is located at McAnnelly's Bend. Fusulinid foraminifers are generally recognized to be among the most reliable fossils for detailed correlation of Pennsylvanian rocks. Until recently, however, fusulinids had not been described or even listed from the type section of the Marble Falls limestone or from rocks of equivalent age in the eastern part of the uplift. In 1942 Thompson described *Millerella marblensis* from the type section of the Marble Falls limestone at Marble Falls, Texas, and listed *Ozawainella?* sp. (= *Nankinella plummeri*, n. sp.) as an associated form. Since that time numerous additional thin sections have been prepared of the type Marble Falls limestone and of samples collected by F. B. Plummer from the Marble Falls limestone at other localities in the southeastern and eastern parts of the Llano Uplift. Also, Plummer kindly went with me during the summer of 1945 to make extensive collections from most of the better known exposures of pre-Desmoinesian Pennsylvanian rocks around the uplift. These later collections have been extensively sectioned.

Some zones in the Marble Falls limestone of the eastern part of the uplift, including one at the type section, are composed largely of fusulinid shells. Although the bulk of these fusulinids is referable to two species, the fauna as a whole is highly diversified. The fauna is now known to contain at least 8 species referable to 6 genera, 7 species of which are described in this report.

The Big Saline limestone in the western part of the Llano Uplift contains prolific faunas of larger fusulinids which permit easy correlation with most rocks of similar age in other regions. Therefore it is important to

[1] Completion of this report was supported in part by the University of Wisconsin Research Committee.

determine the stratigraphic relationship of the Marble Falls limestone on the eastern side of the uplift to the Big Saline limestone exposed on the western margin of the uplift. The Big Saline limestone has been correlated with the upper part of the type Marble Falls limestone, and it generally has been believed that the larger fusulinids were absent from the eastern part of the uplift due to unfavorable environmental conditions and not to a difference in stratigraphic age (*See* Cheney *et al.*, 1945, p. 160). The difficulties that have been encountered in correlating the limestones on the east side of the uplift with those on the west side are clearly emphasized by the divergent opinions expressed in some of the more recent reports on this region, including those by Cheney (1940), Cheney *et al.* (1945), Plummer (1945), and Spivey and Roberts (1946). However, a direct comparison of the fusulinid faunas from the eastern and western parts of the Llano Uplift seems to demonstrate that at least most of the type Marble Falls limestone is considerably different in age from the limestones in the western parts of the uplift and permits correlation among the various outcrops on both sides of the uplift. In this report only the faunas from the eastern part of the uplift are described in detail, but they are compared with those from the western region. The correlations across the Llano Uplift here proposed are based almost exclusively on information obtained from studies of the fusulinid faunas.

The preceding paper in this number by F. B. Plummer summarizes his most recent classification of the pre-Desmoinesian Pennsylvanian rocks of the Llano Uplift. It should be pointed out that the terminology I am using differs from that used by Plummer, especially in that I am employing the term Marble Falls limestone for the limestones on the east side of the uplift and the term Big Saline limestone for those on the west side. Fusulinids do not indicate the type sections of these formations are of the same age.

I wish to take this opportunity to express my sincere thanks to F. B. Plummer for numerous collections, for information concerning local stratigraphy and thickness, for his guidance and help in the field, and for preparing the "Summary of Classification" given in the preceding paper. Field work on which this report is partly based was made possible by a grant from the Graduate Research Committee of the University of Kansas.

STRATIGRAPHIC CONSIDERATIONS

Pre-Desmoinesian Pennsylvanian rocks are exposed in numerous more or less isolated outcrops around the eastern, northern, and western margins of the Llano Uplift. Also, a number of outliers of these rocks are found in the pre-Cambrian to Ordovician older area of the central part of the uplift.

The Marble Falls limestone is well exposed at its type locality along the Colorado River and in the general region near Marble Falls, Texas. The nearest large outcrop of pre-Desmoinesian Pennsylvanian limestone is an isolated outlier about 10 miles south of Llano and about 15 miles west by north of the Marble Falls type exposure. Also, Marble Falls limestone and Smithwick shale are exposed about 40 miles north by slightly west of Marble Falls and in the general region from the town of Bend to the south end of McAnnelly's Bend of the Colorado River. The outcrop of limestone and overlying shale on and near the bluffs at McAnnelly's Bend of Colorado River is the type section of the Bendian series of Dumble (1890), the Bend group of Sellards (1933) and Plummer and Hornberger (1935, p. 65), and of the Lampasan series of Cheney (1940).[1] Pre-Desmoinesian Pennsylvanian

[1] No single or specific outcrop of rocks has been designated as the type section of the Lampasan. Cheney (1940, p. 81) proposed the first usage of the term "Lampasas . . . for beds younger than Morrow but older than type Strawn of the Brazos River Valley section." No rocks of Lampasan age are exposed in the Brazos River Valley but are found there in the subsurface. On the same page Cheney stated: "The name Lampasas is taken from Lampasas County, Texas. . . . The best outcrops of the Lampasas beds are to be found in western Lampasas and eastern San Saba counties near the village of Bend." Later Cheney *et al.* (1945, p. 156) stated that the "type section of the Lampasas series is located around the Llano Uplift of central Texas and in the area north thereof." Although the exposures on McAnnelly's Bend and immediate area have not been specifically stated to be the type section, the name came from that area and these exposures were

rocks are exposed almost continuously along the north side of the Llano Uplift from McAnnelly's Bend westward to near the town of Brady, a distance of about 60 miles around the margins of the uplift.

Isolated outcrops of pre-Desmoinesian Pennsylvanian rocks occur southwest and west of Mason, on the southwest side of the Llano Uplift. The northernmost parts of these outcrops are, however, about 30 miles south of the last continuous outcrop near Brady.

These separated outcrops of pre-Desmoinesian Pennsylvanian rocks may be grouped into five areas of reference (Fig. 1): (I) The outcrops at and near Marble Falls; (II) the outcrop about 10 miles south by east of Llano; (III) the outcrop from McAnnelly's Bend through the town of San Saba to Cavern Ridge; (IV) the outcrop area from Cavern Ridge to near Brady; and (V) the outcrops west and southwest of Mason.

Fusulinids have been studied from all of these areas and have been found throughout the limestones at most of them. Collections have been obtained from throughout most of the Marble Falls limestone in Areas I, II, and III, and permit correlation of certain parts of the section among them. Larger types of fusulinids have not been found in the lower part of the section at any of these latter three localities. So far as now known, the fusulinid fauna from the lower part of the Marble Falls limestone in Areas I and III is composed exclusively of *Millerella*.

Fusulinids occur throughout the limestones in Area IV near Brady and Area V southwest of Mason, and they permit detailed correlation of most of the pre-Desmoinesian limestones within and between these two areas. Considerably difficulty has been encountered in the past in making direct correlations between the three areas of the eastern part of the uplift and the two areas of the western part of the uplift. Studies of the fusulinids now establish with some degree of assurance correlations between the two sides of the uplift. The following discussion is a survey of the evidence obtained from these studies.

Area I. The type section of the Marble Falls limestone has a thin zone about 100 feet below the top that contains a prolific fusulinid fauna composed of abundant *Millerella* (including *M. marblensis* Thompson), *Nankinella plummeri*, n. sp., and *Staffella expansa*, n. sp., and rare specimens of *Eoschubertella texana?* n. sp., and *E.* spp. The lower 125 feet of Marble Falls limestone on Colorado River just east of Marble Falls, referred to the Sloan limestone member of the Marble Falls limestone by Plummer (1945) and described in the preceding paper by Plummer as the Sloan formation, contains only *Millerella* and seems to confirm Plummer's reference of it to the Morrowan series.

Area II. The limestone exposed on Middle Branch just north of Honey Creek and at the cross-section survey, about 10 miles south of Llano, Llano County, contains a prolific fauna of fusulinids composed of abundant *Millerella*, including *M. marblensis*, abundant specimens of *Staffella?* sp., common *Nankinella plummeri*, n. sp., *Eoschubertella texana*, n. sp., and *Profusulinella marblensis*, n. sp., and rare *Pseudostaffella* aff. *P. needhami* Thompson. Samples have not been examined from other parts of the section exposed on Honey Creek.[2]

Area III. The upper part of the Marble Falls limestone (Lemons Bluff spiculite member) south of the town of Bend and at Chappel contains a prolific fusulinid fauna composed of abundant specimens of *Millerella*, *Nankinella plummeri*, n. sp., *Staffella expansa*, n. sp., and *Staffella* sp., scattered specimens of *Profusulinella marblensis*, n. sp., and common specimens of *Eoschubertella texana*, n. sp., and *E.* spp. The lower 125 feet of Pennsylvanian limestone exposed on Aylor Bluff (Aylor limestone member—*See* Plummer above in this number) in McAnnelly's Bend contains a large fauna of *Millerella*, but extensive sectioning of this limestone has not revealed representatives of other genera. The type section of the Sloan limestone opposite Lemons Camp on

stated by Cheney to be the best known for the series. Therefore, if there is an exposed type section of the Lampasan in Texas, it apparently is the section exposed in the McAnnelly's Bend region.

[2] Spivey and Roberts (1946) report *Fusiella* (possibly *Profusulinella marblensis*, n. sp., of this report) near the middle of the Marble Falls of this area.

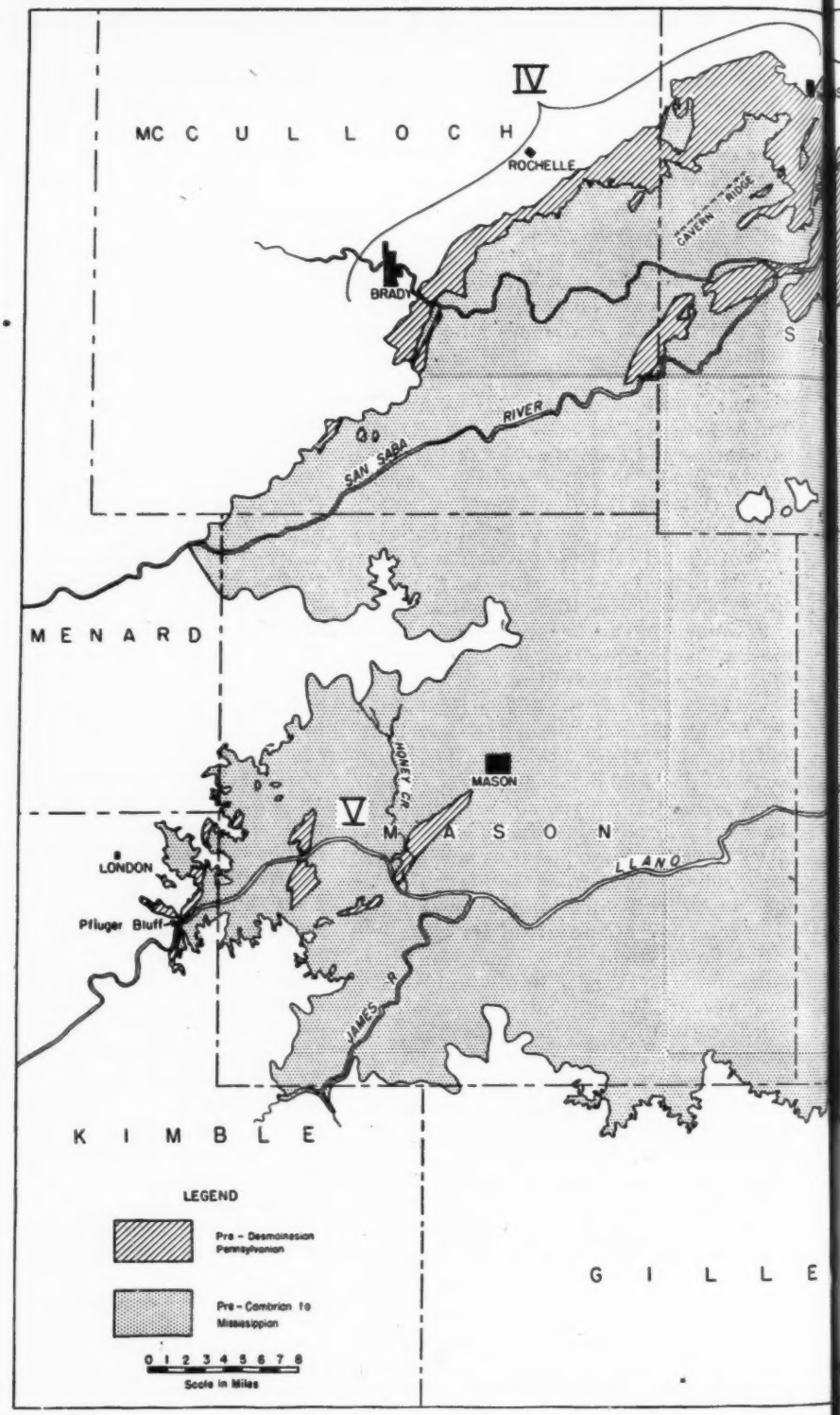
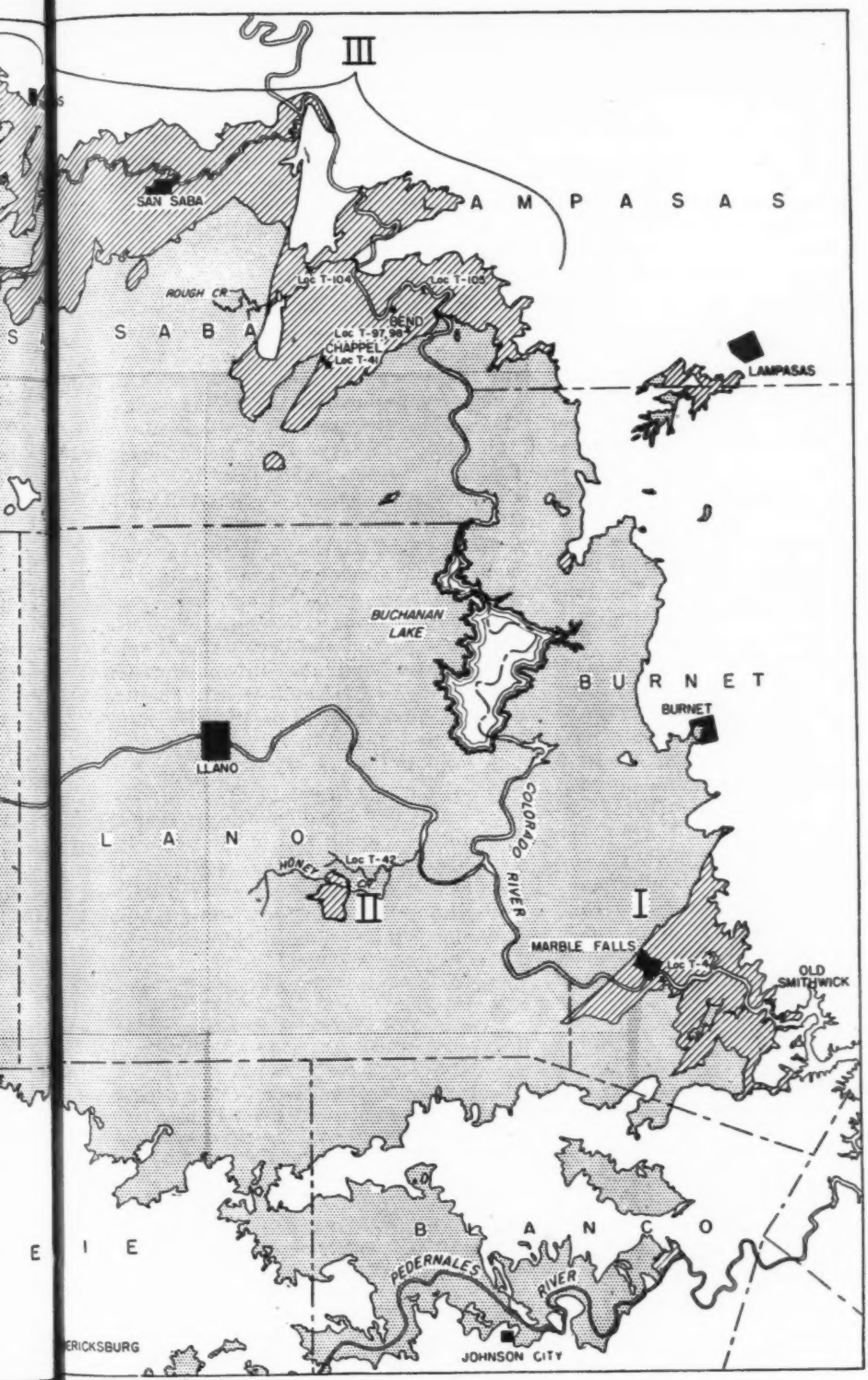


FIG. 1.—Outline map of the Llano Uplift, Texas, [illegible]
All details of map from work by F. B. [illegible]



e outcrop of pre-Desmoinesian Pennsylvanian rocks.
ith Texas Bureau of Economic Geology.

Sloan Ranch west of San Saba contains abundant *Millerella*.

The upper 10 to 25 feet of limestone exposed at the north end of the cliff on the west side of Colorado River at McAnnelly's Bend (Bristor limestone member—*See* Plummer above in this number) contains a large fauna of fusulinids composed of abundant *Millerella*, common *Eoschubertella texana*, n. sp., *Pseudostaffella* aff. *P. needhami* Thompson, *Staffella expansa*, n. sp., and rare *Nankinella* sp. The form of *Eoschubertella* is more or less transitional in nature between typical *Eoschubertella* and primitive *Profusulinella*. Conspecific specimens of this form of *Eoschubertella* are also present in the upper part of the Marble Falls at Chappel and on Honey Creek south of Llano.

The upper few feet of the massive limestone at the top of the Marble Falls limestone on Rough Creek (Bristor limestone member), about 6½ miles west of Bend, contains a fusulinid fauna of primitive *Profusulinella*, *P. marblensis*, n. sp., abundant *Millerella*, rare *Pseudostaffella* aff. *P. needhami* Thompson and rare *Eoschubertella* sp. The middle part of the Marble Falls exposed at Rough Creek (Lemons Bluff spiculite member) contains abundant *Staffella expansa*, n. sp. Plummer (1945) correlates the upper limestone at Rough Creek with the upper limestone on the north end of the bluffs in McAnnelly's Bend. Spivey and Roberts (1946) report "*Fusulinella*" was discovered by Bruce H. Harlton 0.75 miles south of Bend in the uppermost Marble Falls limestone or limestone in the lower part of the Smithwick shale. Harlton[3] writes me that the form from south of Bend is the same form as described below from Rough Creek as *Profusulinella marblensis*.

Area IV. The pre-Desmoinesian Pennsylvanian rocks between Cavern Ridge and Brady contain prolific fusulinid faunas composed of numerous undescribed species of *Millerella*, *Nankinella*, *Staffella*, *Eoschubertella*, *Pseudostaffella*, *Profusulinella*, and *Fusulinella*. A few feet of shale at the base of the Brook Ranch limestone member of the Big Saline limestone, and above a thin zone of questionable Sloan limestone at Onion Creek Crossing on Richards Ranch, McCulloch County (*See* Helen Jeanne Plummer, 1945, p. 255, Loc. 153-T-136), contains an abundant fusulinid fauna of *Millerella*, *Nankinella*, *Staffella*, *Eoschubertella*, *Pseudostaffella*, and *Profusulinella*. Some of the species of *Millerella*, *Nankinella*, *Staffella*, and *Eoschubertella* found here may be conspecific with those from the upper part of the Lemons Bluff spiculite member and the Bristol limestone member of Area III and Area I. The form of *Profusulinella* found on Richards Ranch has not been found in the region east and southeast of Cavern Ridge. It seems important that this species of *Profusulinella* is more highly developed biologically than the *Profusulinella* found east of the ridge. It is concluded that the basal part of the fusulinid-bearing limestones studied by me in the Rochelle-Brady area is stratigraphically higher than the fusulinid-bearing part

[3] Harlton, Bruce H., Personal communication.

EXPLANATION OF PLATE 31

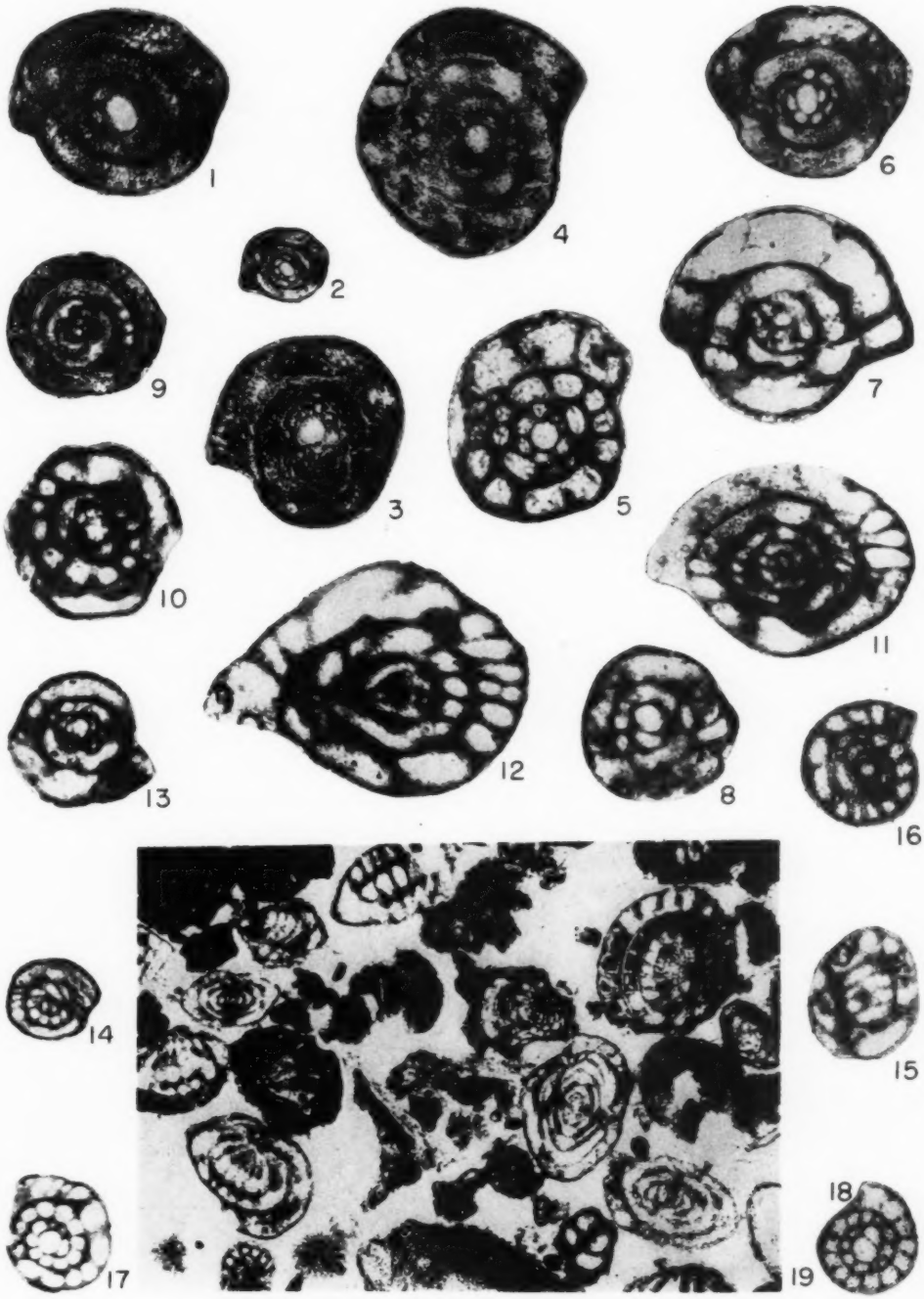
FIGS. *1–8*—*Eoschubertella texana* Thompson, n. sp. *1*, Axial section of the holotype, ×50; *2*, axial section of the holotype at magnification commonly used to illustrate lower Pennsylvanian fusulinids, ×20; *3*, *4*, oblique sagittal sections of paratypes, ×50; *5*, sagittal section of a paratype, ×50; *6–8*, axial sections of paratypes, ×50. Specimens of *1–4* from Loc. T-41, *6* from Loc. T-42, *5*, *7*, *8* from Loc. T-105. (p. 161)

9, *10*—*Pseudostaffella* aff. *P. needhami* Thompson. Axial sections, ×50. Specimen of *9* is from Loc. T-42, and *10* is from Loc. T-105. (p. 160)

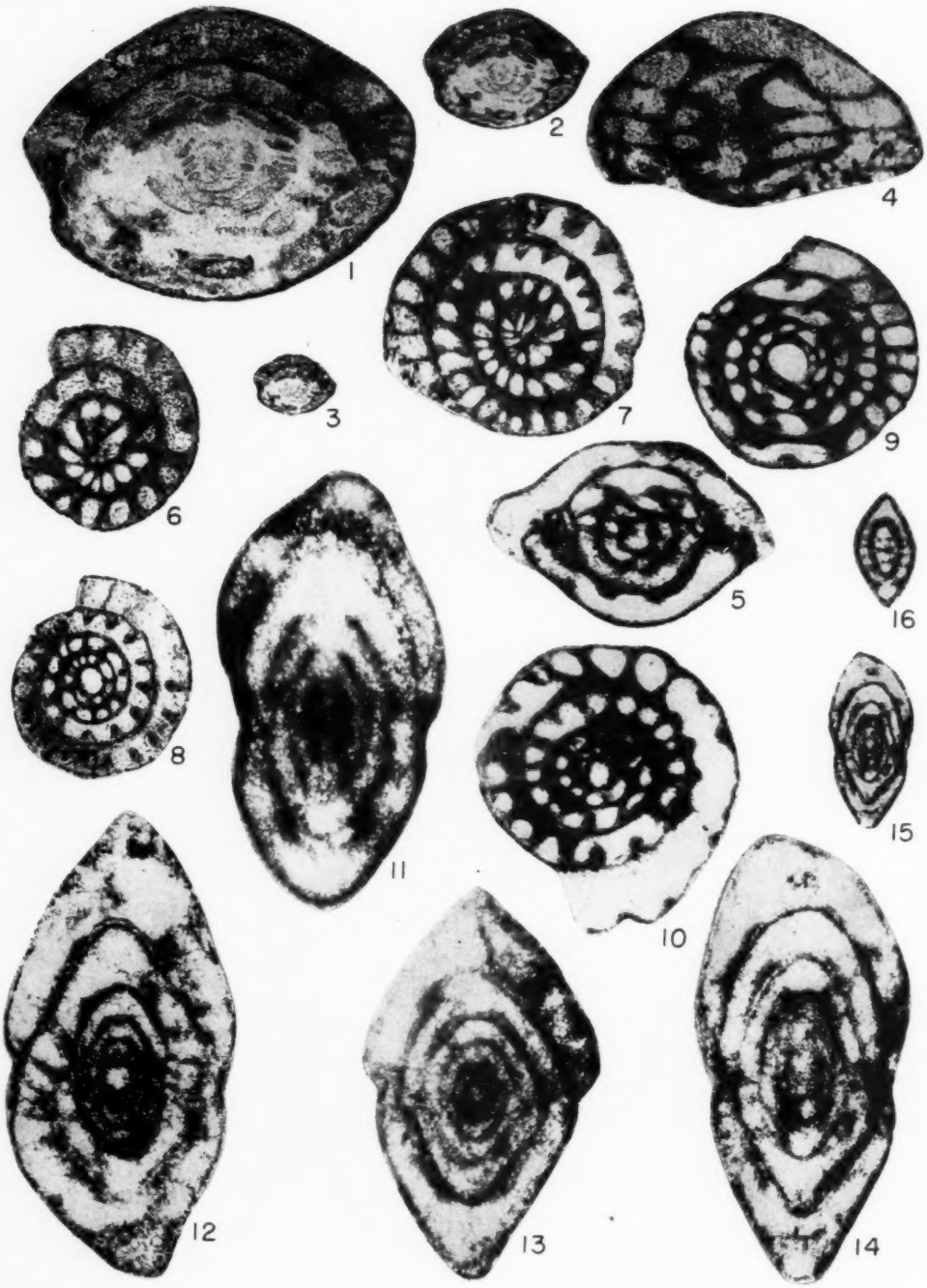
11, *12*—*Profusulinella marblensis* Thompson, n. sp. *11*, Oblique axial section of a paratype that shows attitude of septa and development of chomata; *12*, tangential section showing attitude of septa. Both ×50 and both from Loc. T-105. (*See also* Pl. 2.) (p. 162)

13–18—*Eoschubertella* spp. *13*, Axial section; *14*, *15*, tangential sections; *16–18*, sagittal sections; all ×50. Specimen of *13* is from Loc. T-105; *14*, *17* are from Loc. T-42; *15*, *16*, *18* are from Loc. T-14. (p. 162)

19—*Staffella expansa* Thompson, n. sp. Thin section of limestone from Loc. T-41 showing abundance of paratypes at this locality, ×20. (*See also* Pl. 3.) (p. 157)



Thompson, Pennsylvanian Fusulinids



Thompson, Pennsylvanian Fusulinids

of the Marble Falls limestone east of Cavern Ridge. *Profusulinella* extends considerably above the base of the limestones exposed along the bluffs of Onion Creek near Soldiers Hole. The upper part of the limestone in this region (Soldiers limestone member—*See* Plummer above in this number) contains a prolific fauna of *Fusulinella*. Most of the more highly developed species of *Fusulinella* found here are also present in the outcrops southwest and west of Mason (Area V).

Area V. The limestones that outcrop immediately southwest of Mason, and intermittently for about 21 miles southwest and west of Mason, contain a prolific fusulinid fauna of *Millerella*, *Nankinella*, *Staffella*, *Pseudostaffella*, *Eoschubertella*, *Profusulinella* and *Fusulinella*. The lower 88 feet of the limestone exposed on Honey Creek about 7 miles southwest of Mason contains abundant *Profusulinella*, associated with several more primitive types of fusulinids. The upper part of the limestone exposed there contains a prolific fauna of *Fusulinella*, all species of which, including *F. llanoensis* (Thomas), seem to have short stratigraphic ranges.

At least 12 distinct zones of fusulinid-bearing rocks have been sectioned and studied from throughout the series of limestones exposed on Pfluger Bluff and immediate area near the mouth of Big Saline Creek south of London. The fauna is quite varied and contains, in addition to *Fusulinella? primaeva* (Skinner) and *Fusulinella llanoensis* (Thomas), a number of undescribed species of *Millerella*, *Staffella*, *Eoschubertella*, *Pseudostaffella*, and *Fusulinella*. The basal 1 foot of shale and the immediately overlying 5-foot ledge of limestone contain a prolific fauna of *Millerella*, *Nankinella?*, *Staffella*, *Eoschubertella*, and *Fusulinella? primaeva* (Skinner). Argillaceous limestones and hard limestones 10 feet above the base of the Pennsylvanian at Pfluger Bluff are composed largely of shells of an undescribed species of *Fusulinella*. All fusulinid zones above this level contain abundant specimens of *Fusulinella* but, so far as can be determined, no species of *Profusulinella*.

It should be pointed out that the lowermost *Fusulinella* observed at Onion Creek crossing south of Rochelle is more highly developed biologically than the lowermost *Fusulinella* studied from Honey Creek southwest of Mason and at Pfluger Bluff. However, a considerable gap occurs between the highest collection of *Profusulinella* and the lowest collection of *Fusulinella* I have from near Onion Creek crossing. The *Fusulinella*, an undescribed species, that occurs near the top of the Soldiers limestone member in the regions near Brady and Rochelle is also present in the upper part of the limestone at Pfluger Bluff. It seems important that *Fusulinella? primaeva* (Skinner) from the basal 5 feet of the Pfluger Bluff section occurs about 88 feet above the base of the Honey Creek section southwest of Mason and also above a prolific fauna of *Profusulinella*.

STRATIGRAPHIC SUMMARY

Conclusions in regard to correlation among the different outcrops of pre-Desmoinesian rocks in the area of the Llano Uplift, as based largely on fusulinid studies, are summarized in the following paragraphs.

First.—The Sloan limestone member of the Marble Falls limestone is lower Pennsylvanian in age and is stratigraphically older

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EXPLANATION OF PLATE 32

FIGS. *1–10*—*Profusulinella marblensis* Thompson, n. sp. *1–3*, Axial section of the holotype, magnified ×50, ×20, and ×10, respectively, for comparison with common magnifications at which fusulinids are commonly illustrated; *4*, tangential section of a paratype, ×50; *5*, axial section of a paratype, ×50; *6*, *7*, parallel sections of paratypes, ×50; *8–10*, sagittal sections of paratypes, ×50. Specimens of *1–4*, *6–9* are from Loc. T-42, *5*, *10* are from Loc. T-105. (*See also* Pl. 1.) (p. 162)

11–16—*Nankinella plummeri* Thompson, n. sp. *11*, Axial section of the holotype, ×50; *12–15*, axial sections of paratypes, *12–14* ×50, *15* same as *14* but ×20; *16*, tangential section of a paratype, ×20. All from Loc. T-4. (p. 155)

than the Atoka formation of Oklahoma, any part of the Big Saline limestone on the west side of the uplift, and the Derryan series of New Mexico. It apparently is the approximate time equivalent of the Morrowan of Arkansas, the Wapanucka limestone of eastern Oklahoma, the Johns Valley shale of southeastern Oklahoma, the lower part of the Dornick Hills formation of the Ardmore Basin of Oklahoma, the Morrowan rocks of Hueco Mountains, Texas, the Kearny formation of Kansas, the Belden formation of Colorado and Utah, and part of the "Amsden" formation of Wyoming and Montana.

Second.—The fusulinids in the upper part of the Marble Falls limestone on the eastern side of the Llano Uplift are all primitive in nature. The presence here of a mixture of biologically primitive types, such as *Millerella*, *Nankinella*, *Staffella*, and *Eoschubertella*, associated directly with a biologically primitive member of the subfamily Fusulininae, *Profusulinella marblensis*, n. sp., indicates that the more highly developed members of the subfamily Fusulininae are not absent on the east side of the uplift due to unfavorable environmental conditions. This strongly suggests that the upper fusulinid-bearing parts of the Marble Falls limestone are stratigraphically older than the pre-Desmoinesian rocks on the west side of the uplift which contains more highly developed representatives of Fusulininae. Pre-Desmoinesian rocks of other regions considered stratigraphically younger than the Marble Falls on the eastern side of the Llano Uplift that may be mentioned specifically are the fusulinid-bearing part of the Atoka formation of Oklahoma, that part of the Dornick Hills formation of the Ardmore Basin of Oklahoma between and including the Bostwick limestone member to the Lester limestone member, the type section of the Big Saline limestone at Pfluger Bluff on the west side of the Llano Uplift, and that part of the Derryan series of New Mexico between and including the Apodaca formation of the Green Canyon group and the Cuchillo Negro formation of the Mud Springs group.

One of the most nearly complete suites of fusulinids known in America that includes one of the first known members of the genus *Profusulinella* through to the maximum development of *Fusulinella* is found in the Derryan and lower Desmoinesian rocks of New Mexico and extreme western Texas. All counterparts of the fusulinid faunas of the post-Morrowan to pre-Desmoinesian rocks in the Llano Uplift are found in the Derryan rocks of New Mexico and western Texas. The unquestionable post-Morrowan primitive fusulinid faunas of the Marble Falls limestone of Areas I, II, and III are closely similar to the fusulinid faunas found in the lower part of the type Derryan of New Mexico and in rocks of equivalent age in the Hueco Mountains of Texas. Furthermore, stratigraphically higher parts of the Derryan of New Mexico and extreme West Texas contain faunas of *Profusulinella* and *Fusulinella* almost identical to those found on the west side of the Llano Uplift. It therefore seems almost certain that the fusulinid faunas on the east side of the uplift are stratigraphically older than any of the fusulinid faunas collected from limestones west of Cavern Ridge.

Third.—Fusulinids from Onion Creek south of Rochelle, the region south of Brady, Honey Creek southwest of Mason, and Pfluger Bluff on the Llano River furnish information to explain the stratigraphic relationships of the lower Pennsylvanian in the western part of the uplift. It seems evident that the fusulinid-bearing basal beds at Onion Creek (unconformably above questionable Sloan limestone) are more primitive than the basal beds at Honey Creek (Mason County), and those at Honey Creek are more primitive than the basal beds at Pfluger Bluff. The pre-Desmoinesian rocks west of Cavern Ridge, therefore, are believed to progressively overlap older beds in a westerly direction. Although the sections examined indicate westward overlap, fusulinids from a sufficient number of sections were not examined to demonstrate that the overlap was uniform and uninterrupted.

Fourth.—In regard to the entire region of the Llano Uplift, the fusulinids indicate that the Sloan limestone probably is Morrowan in age. Plummer pointed out above that this member does not extend to the western side of the uplift. The highest fusulinid faunas

studied from the upper part of the Marble Falls limestone on the east side of the uplift are more primitive stratigraphically than any studied from the Big Saline limestone on the west side of the uplift. Since some of these faunas are from the uppermost part of the Marble Falls limestone of Area III, most of the Marble Falls limestone on the east side of the uplift is absent on the west side due to truncation and overlap or to progressive overlap. It seems that a large part if not all of the Big Saline limestone at Pfluger Bluff on Llano River is either absent on the east side of the uplift or is represented there by the Smithwick shale.

A summary of these stratigraphic correlations is shown in the accompanying diagram (Fig. 2).

COLLECTION LOCALITIES

The type specimens as well as all illustrated specimens of species described in this report came from the following localities:

T-4. Type locality of Marble Falls limestone. Collected from near water level on the south side of Colorado River about 150 yards downstream from the highway bridge at Marble Falls, Burnet County, Texas: *Millerella* spp., *Millerella marblensis* Thompson, *Nankinella plummeri*, n. sp., *Staffella expansa*, n. sp., *Eoschubertella texana* (?), n. sp., *Eoschubertella* spp. M. L. Thompson, April 1941.

T-41. Marble Falls limestone. Collected from an outcrop ½ mile northwest of the town of Chappel, and on the north side of the Chappel-San Saba road, at the top of the Marble Falls limestone of this immediate area, San Saba County, Texas: *Millerella* spp., *Nankinella plummeri*, n. sp., *Staffella expansa*, n. sp., *Eoschubertella texana*, n. sp., *Profusulinella marblensis*, n. sp. F. B. Plummer, 1942 (Texas Bureau Economic Geology, Loc. 205-T-117).

T-42. Marble Falls limestone. Collected from Middle Branch, north side of Honey Creek, 1 mile northwest of Honey Creek School, Llano County, Texas: *Millerella* spp., *Nankinella plummeri*, n. sp., *Staffella* sp., *Pseudostaffella* aff. *P. needhami* Thompson, *Eoschubertella texana*, n. sp., *Eoschubertella* spp., *Profusulinella marblensis*, n. sp. F. B. Plummer, 1942 (Texas Bureau Economic Geology, Loc. 149-T-5).

T-97 and 98. Marble Falls limestone. On the side of the Bend-Chisholm Camp road about 2 miles south of Bend: *Millerella* spp., *Nankinella plummeri*, n. sp., *Staffella expansa*, n. sp., *Staffella* sp., *Eoschubertella texana?*, n. sp., *Eoschubertella* spp. F. B. Plummer, 1942 (Texas Bureau Economic Geology, Loc. 205-T-18).

T-104. Marble Falls limestone. Collected from the top of the cliff on the north side of Rough Creek, just west of the Bend-San Saba road crossing, 6½ miles west of Bend, San Saba County: *Millerella* spp., *Pseudostaffella* aff. *P. needhami* Thompson, *Eoschubertella* sp., *Profusulinella marblensis*, n. sp., M. L. Thompson, July 1945.

T-105. Marble Falls limestone. Collected from the upper 10 to 25 feet of Marble Falls limestone at the north end of the cliff on the west side of the Colorado River in the northeastern part of Mc Annelly's Bend, about 2 miles northeast of Bend, San Saba County, Texas: *Millerella* spp., *Nankinella* sp., *Staffella expansa*, n. sp., *Eoschubertella texana*, n. sp., and *Pseudostaffella* aff. *P. needhami* Thompson. M. L. Thompson, 1945.

SYSTEMATIC DESCRIPTIONS

NANKINELLA PLUMMERI Thompson, n. sp.
Plate 32, figures 11–16; Plate 33, figures 10, 11

Ozawainella? THOMPSON, 1942, Am. Jour. Sci., vol. 240, p. 407.

Exceedingly abundant specimens of a discoidal form that have subellipsoidal juvenile shell with narrowly rounded periphery occur in the Marble Falls limestone at many localities in the Llano Uplift. As maturity is approached the polar regions become depressed (umbilicate) and the peripheral margins become bluntly to sharply angular. The genotype of *Nankinella* Lee, *Staffella discoides* Lee, is not clearly understood, for the illustrated type specimens are not well oriented and they obviously are highly replaced by secondary mineralization. However, the Texas form is more closely similar to *Staffella discoides* than any other proposed genotype, and it is referred to *Nankinella*. It is realized that they may not be congeneric.

As in the case of the form referred below to *Staffella*, all shells of the form described below as *Nankinella plummeri* are entirely replaced by secondary mineralization.

Description.—Shell minute, discoidal, planispiral and symmetrical, umbilicate; with straight axis of coiling, angular periphery at maturity, convex lateral slopes. Mature shells of 5½–6 volutions 1.26–1.32 mm. wide, 0.52–0.54 mm. in axial length and 0.62–0.72 mm. in maximum length. Form ratio of axial length 0.41–0.48. Two types of specimens referred to this form are of about equal abundance in most samples. One of these types, including the holotype, has a small proloculum. The other type has

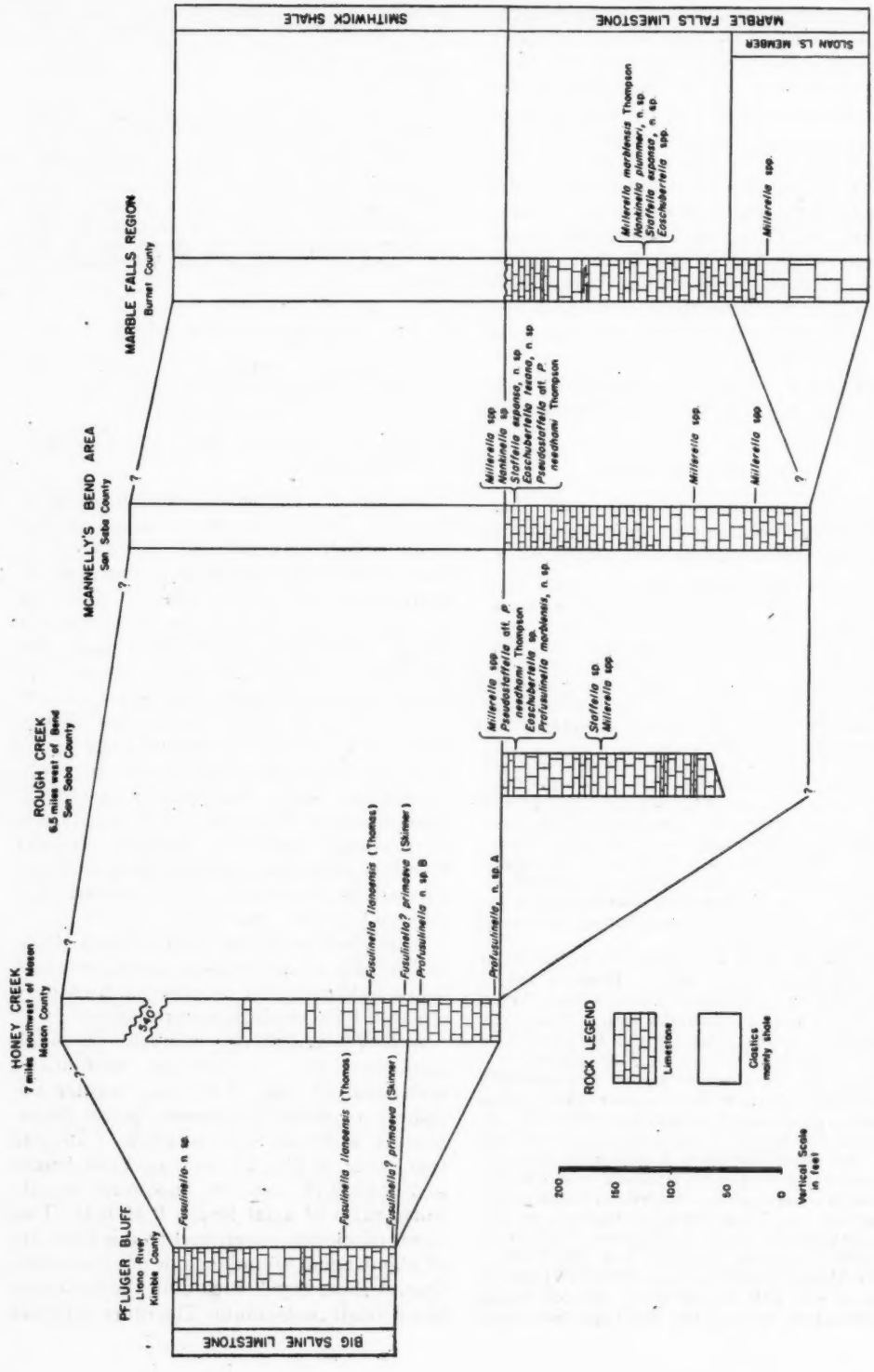

FIG. 2.—Diagrammatic correlations of some pre-Desmoinesian Pennsylvanian rocks of the Llano Uplift as based on fusulinids. Stratigraphic section generalized from work of F. B. Plummer.

a relatively larger proloculum and slightly longer axial diameter than the holotype. Most statistical data of the first to fifth volutions of the latter type of specimens check closely with the data of the second to sixth volutions of the former type of specimens. All volutions symmetrical. First 3–4 volutions non-umbilicate, outer volutions gradually become more deeply umbilicate. In the holotype and closely similar specimens the last volution does not completely embrace all of the preceding volutions and therefore shell is slightly evolute. Form ratios of first to sixth volution of holotype 0.62, 0.50, 0.43, 0.51, 0.51, and 0.42, respectively.

Proloculum minute in some specimens including the holotype, small in others. Outside diameter in holotype 37 microns—in some specimens as large as 85 microns. Average heights of chambers above tunnel in first to sixth volution of 2 typical specimens 22, 42, 76, 112, 155, and 197 microns, respectively. Heights of first to fifth volution of a specimen with a larger proloculum 34, 44, 68, 105, and 204 microns, respectively.

Spirotheca thin. The spirotheca was replaced during fossilization by secondary mineralization of chert and calcite. Structure not determined with certainty. Average thicknesses of spirotheca in second to sixth volution of 3 specimens 10, 12, 18, 19, and 19 microns, respectively. Spirotheca of essentially uniform thickness in central half of shell, becomes thin in polar regions. In parts of some specimens the spirotheca apparently has three layers. Where the original wall is more nearly completely replaced by chert, the spirotheca has the appearance of a four-layered structure.

Septa unfluted throughout length of shell, arcuate anteriorly, and extend forward at angle of about 10 degrees to normal with spirotheca. Upper part of septa contains thin dense layer near center. Septal counts of fourth, fifth, and sixth volutions of one specimen 19, 23, and 19, respectively.

Tunnel low and broad, path straight. Tunnel angles of fourth to sixth volution about 20, 26, and 23 degrees, respectively. Chomata low, asymmetrical. Tunnel side steep, poleward slope low. In outer 3 volutions chomata extend slightly more than half distance to poles.

Remarks.—Nankinella plummeri does not closely resemble any previously described American forms. However, closely similar but undescribed forms occur in the lower part of the Derryan of New Mexico and extreme West Texas where they are associated with an abundant fauna of *Millerella*, *Staffella*, and primitive forms of *Profusulinella* closely similar to the species of *Profusulinella*, *P. marblensis*, described below from the Marble Falls limestone.

This species is named in honor of Dr. F. B. Plummer.

Occurrence.—Nankinella plummeri is abundant in the Marble Falls limestone about 150 yards downstream from the bridge and near water level at Marble Falls, where it is associated with abundant *Millerella marblensis* Thompson, scattered specimens of *Staffella expansa*, n. sp., and common *Eoschubertella texana*, n. sp. It is also common in the Marble Falls limestone near Chappel, San Saba County, where it is associated with abundant *Millerella*, abundant *Staffella expansa*, n. sp., common *Eoschubertella texana*, n. sp., and common *Profusulinella marblensis*, n. sp. This form is common in the Marble Falls limestone in the region south of the town of Bend and in the region of McAnnelly's Bend, where all of the above forms, except *Profusulinella marblensis*, n. sp., have been found associated with it. Abundant poorly preserved specimens of this form occur in the Marble Falls limestone on Honey Creek 10 miles south of Llano, Llano County, associated with abundant *Profusulinella marblensis*, n. sp., *Staffella* sp., common *Eoschubertella texana*, n. sp., and abundant *Millerella*.

The lower part of the Pennsylvanian Big Saline section on Pfluger Bluff contains common specimens of a discoidal form that may be conspecific with the holotype of *Nankinella plummeri*.

STAFFELLA EXPANSA Thompson, n. sp.
Plate 31, figure 19; Plate 33, figures 1–4

A sample sent me by F. B. Plummer from an outcrop of upper Marble Falls limestone in the northwest corner of the small town of Chappel (Texas Bureau of Economic Geology, Locality 205-T-117; Thompson, Locality T-41) is composed largely of the shells of a fusulinid here referred to *Staffella* Ozawa.

Stratigraphic section generalized from work of F. B. Plummer.

The genotype of *Staffella*, *S. moellerana* Thompson, is from the Permian Djulfa beds of Armenia. Illustrations of *S. moellerana* published by Möller (1878) and by Licharew *et al.* (1939) indicate that *Staffella* has a subdiscoidal early stage and subspherical umbilicate mature shell. The form here described as *S. expansa* has a discoidal shell during the development of the first 4–5 volutions, and the mature shell becomes subspherical in shape and is highly umbilicate. The Texas form is more closely similar to *S. moellerana* than to any other genotype and is accordingly referred to *Staffella*.

All the type specimens of *Staffella expansa* from Chappel are replaced by chert and secondary calcite. Associated with them, however, are specimens of *Millerella*, *Profusulinella marblensis*, n. sp., and *Eoschubertella texana*, n. sp., many of which are not replaced by secondary mineralization. At all other localities where *S. expansa* is found in the Llano Uplift, the shells are entirely replaced by chert or secondary calcite. At several of them, *S. expansa* is associated with specimens of *Millerella*, *Eoschubertella*, and *Profusulinella* that are not replaced by secondary mineralization. The shells of the forms described in this report as *Nankinella plummeri*, n. sp., and *Staffella* sp. are entirely replaced by chert and secondary calcite, but forms of other fusulinid genera associated with them are only slightly, if at all, replaced. Furthermore, species of *Nankinella* and *Staffella* throughout the world are generally replaced by chert or secondary calcite. Associated forms of other genera of fusulinids in many areas throughout the world are not replaced. This replacement suggests that the original shell composition of these discoidal and subspherical forms was not the same as the shell composition of other fusulinids.

Description.—Shell small, subspherical, highly umbilicate at maturity, periphery rounded, lateral slopes highly convex. Mature specimens of 7–8 volutions about 1.2–1.7 mm. wide, 0.54–0.64 mm. in axial length, 0.62–0.76 mm. in maximum length. Form ratio of axial length to width about 0.43, that of total length about 0.54. The inner 4 volutions have convex polar region, outer volution umbilicate, with depth of umbilici increasing with growth of shell. Form ratios of axial length to width of first to seventh volution of the holotype 0.57, 0.66, 0.55, 0.60, 0.54, 0.45, and 0.39, respectively. Average form ratios of first to seventh volution of 3 typical specimens 0.63, 0.65, 0.55, 0.60, 0.58, 0.48, and 0.39, respectively.

Spirotheca thin. As shell material is entirely replaced by secondary mineralization, original structure not definitely known. Spirotheca deflective downward to form septa, and tectum can be observed at junction. Thin layer near center of septa that is continuous with tectum of spirotheca of preceding chamber suggests a 3-layer spirotheca. As observed in most thin sections, spirotheca composed of a homogeneous layer. Spirotheca of essentially uniform thickness in central one-half of shell, decreases in thickness markedly in polar regions. Thickness of spirotheca above tunnel in fourth to eighth volution about 8, 15, 17, 20, and 20 microns, respectively.

Proloculum minute in size, spherical in shape. Outside diameter 31–41 microns, averaging 35 microns for 4 specimens. Shell expands somewhat uniformly. Average heights of first to eighth volution of 3 specimens 20, 35, 53, 80, 98, 127, 152, and 184 microns, respectively.

Septa closely spaced. Immediately above tunnel septa extend forward at angle of about 10 degrees to normal to spirotheca. Poleward from region of tunnel, angle of inclination of septa increases. Septal counts of first to eighth volution of illustrated sagittal section 11, 14, 17, 16, 17, 22, 25, and 25, respectively. Septa unfluted throughout length of shell.

Tunnel narrow, elliptical in cross section, path essentially straight throughout shell. Tunnel angle in sixth, seventh, and eighth volution about 10, 17, and 23 degrees, respectively. Chomata low and relatively wide, tunnel slope steep, poleward slope low; poleward margin extends approximately half distance from tunnel to poles in seventh and eighth volutions.

Remarks.—*Staffella expansa* is most closely similar to *S. leei* Doutkevitch originally described from well samples at a depth of 996.5 meters on the west side of the Middle Ural Mountains, Russia. The Russian form is larger and has a relatively

larger proloculum. The general shell outline and internal features of these forms, however, are closely similar. Apparently the Russian form is considerably younger stratigraphically than *S. expansa*, for it is reported to be associated with the Permian genus *Pseudofusulina* (*Schwagerina*).

No forms closely similar to *Staffella expansa* have been described from America.

Occurrence.—*Staffella expansa* is exceedingly abundant in the Marble Falls limestone exposed in the northwest corner of the small town of Chappel, San Saba County (Loc. T-41). It is common in the upper part of the Marble Falls limestone on the Chisholm Camp road south of Bend, San Saba County (Loc. T-97, T-98) and rare in the Marble Falls limestone near water level about 150 yards downstream from the bridge at Marble Falls, Burnet County (Loc. T-4).

TABLE OF MEASUREMENTS (IN MILLIMETERS) OF STAFFELLA EXPANSA

Specimen	L.	W.	Ratio	No. of volutions	Diam. of prol.	Height of volutions 1	2	3	4	5	6	7	8
1	0.64	1.33	0.48	7½	.034	.017	.038	.054	.076	.093	.143	.152	.152
2	0.37	0.71	0.52	5½	.041	.024	.034	.054	.082	.085	.119	—	—
3	0.54	1.2	0.45	7½	—	—	—	—	—	—	—	—	—
4	—	1.59	—	8	.034	.020	.034	.051	.082	.116	.119	.153	.217

	Form ratio of volutions 1	2	3	4	5	6	7	Thickness of spirotheca 4	5	6	7	8
1	0.57	0.66	0.55	0.60	0.54	0.45	0.39	—	.014	—	.020	.017
2	0.71	0.64	0.53	0.60	0.59	0.52	—	.009	.017	.010	—	—
3	0.60	0.66	0.56	0.60	0.63	—	—	—	.014	.017	.020	.020

	Septal count 1	2	3	4	5	6	7	8	Tunnel angle (degrees) 5	6	7	8
1	—	—	—	—	—	—	—	—	—	10	17	23
2	—	—	—	—	—	—	—	—	12	—	—	—
4	11	14	17	16	17	22	25	25	—	—	—	—

STAFFELLA sp.
Plate 33, figures 5–9

Numerous collections from the Marble Falls limestone in the eastern part of the Llano Uplift contain abundant specimens of a form that is so highly silicified that many of its internal features can not be determined with certainty. This form represents an undescribed species, but because my specimens are so poorly preserved I hesitate to propose a name for them. For the sake of completeness, I am illustrating some of my better preserved specimens and have drawn up the following general description.

Shell small, spheroidal, highly umbilicate at maturity, with broadly rounded periphery, highly convex lateral slopes, and straight axis of coiling. Mature specimens of 6–7 volutions about 1.1–1.4 mm. wide, 0.76 mm. in axial length and 0.9 mm. in total length. The inner 3–4 volutions are distinctly discoidal, with sharply angular periphery. Beyond fourth volution to maturity, shell gradually develops more broadly rounded periphery. Form ratio of fourth volution about 0.55, from there to maturity form ratio of axial length decreases slightly. Structure of spirotheca not determined. Septa relatively thick, essentially normal to spirotheca. Septal counts of fourth to seventh volutions about 13, 17, 23, and 25, respectively. Septa unfluted throughout length of shell.

Proloculum small, outside diameter about 70 microns. Heights of chambers above tunnel in fourth to seventh volution about 68, 90, 100, and 118 microns, respectively.

Tunnel wide and relatively high, path straight throughout shell. Chomata massive and broad, more than half as high as chamber in outer 3 volutions. Tunnel sides steep, poleward slopes low. Tunnel angles of fifth, sixth, and seventh volutions about 20, 25, and 30 degrees, respectively.

Remarks.—*Staffella* sp. resembles in general size *Staffella expansa*, n. sp. Also, the general outline of the inner 3–4 volutions of these forms is somewhat similar. The outline of mature shells of these forms is quite different, however. *S. expansa* has more narrowly rounded periphery and is less deeply umbilicate. In *S. expansa* the chomata are poorly developed, whereas the specimens referred to as *S.* sp. have massive and broad chomata.

Occurrence.—Specimens here referred to as *Staffella* sp. are abundant in the Marble Falls limestone on Honey Creek, about 10 miles south of Llano, Llano County (Loc. T-42), where they are associated with abundant *Millerella*, common *Eoschubertella texana*, n. sp., and common *Profusulinella marblensis*, n. sp. It is abundant in the upper part of the Marble Falls limestone on the Bend-Chisholm Camp road 1½ to 2 miles southeast of Bend, San Saba County (Loc. T-97, T-98), where it is associated with abundant *Millerella marblensis*, common *Nankinella plummeri*, n. sp., and rare *Eoschubertella* spp.

Pseudostaffella aff. P. needhami Thompson
Plate 31, figures 9, 10

Pseudostaffella needhami Thompson, 1942, Am. Jour. Sci., vol. 240, pp. 411, 412, pl. 1, figs. 15–20; pl. 3, figs. 10–14.

A few specimens of *Pseudostaffella* have been obtained from the upper part of the Marble Falls limestone on Middle Branch north of Honey Creek about 10 miles south of Llano (Loc. T-42), in the upper few feet of the Marble Falls limestone west of the road crossing of Rough Creek, 6½ miles west of Bend (Loc. T-104), and in upper Marble Falls on the west bluffs of McAnnelly's Bend (Loc. T-105). All specimens are well preserved, but most of them are not well oriented. They resemble the types of *P. needhami* from the upper part of the Cuchillo Negro formation of New Mexico, but not enough information can be obtained from them for detailed specific comparison. Information available indicates that they have affinities with *P. needhami*.

One of the illustrated oblique axial sections of 4½ volutions is about 0.44 mm. long and 0.51 mm. wide, giving a form ratio of about 0.86. Several specimens of 3 volutions from the Rough Creek locality are about 0.37 mm. long and 0.46 mm. wide, giving a form ratio of about 0.80. First 1–2 volutions coiled at large angle to coiling of outer volutions. Chomata relatively massive and wide, one-half to three-fourths as high as chambers, both slopes low, slightly steeper on tunnel side. Chomata extend almost to poles. Spirotheca composed of tectum and upper and lower tectoria. Tectoria thick. Septa unfluted throughout length of shell. Septal count of second volution of one specimen 12. Proloculum of one specimen has outside diameter of about 78 microns. Heights of first to fourth volution in 2 specimens 27–34, 34–48, 48–95, and 85 microns, respectively.

Remarks.—The general appearance and statistical data of the Texas specimens agree closely with the types of *Pseudostaffella needhami* from New Mexico. However, more material is needed from Texas before definite specific comparisons can be made.

Occurrence.—This form is rare in the upper part of the Marble Falls limestone at Middle Branch north of Honey Creek 10 miles south of Llano (Loc. T-42), where it is

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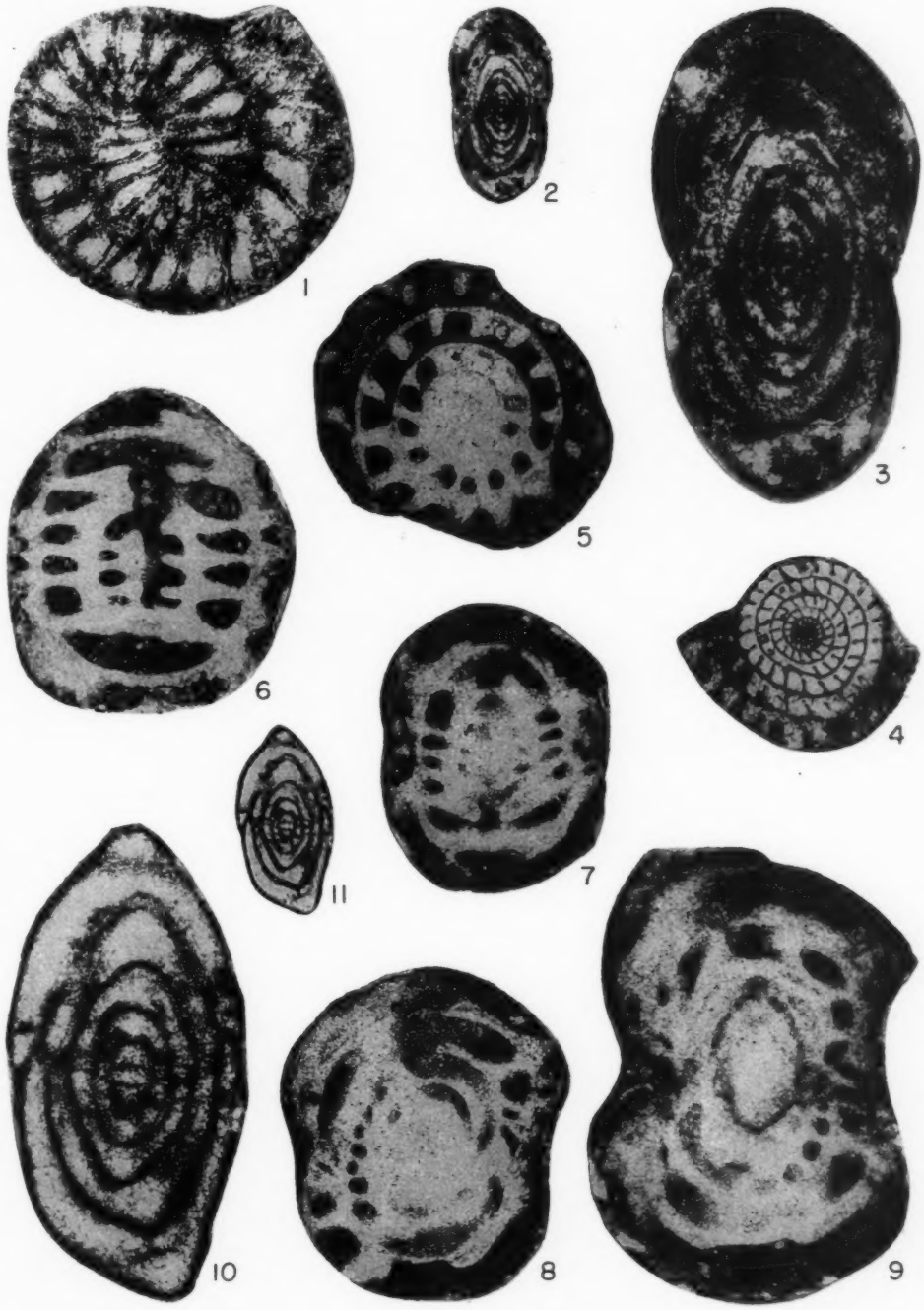
Explanation of Plate 33

Figs. *1–4*—*Staffella expansa* Thompson, n. sp. *1*, Parallel section of a paratype, ×50; *2*, *3*, axial section of the holotype, ×20 and ×50, respectively; *4*, sagittal section of a paratype, ×20. All from Loc. T-41. (*See also* Pl. 1.) (p. 157)

5–9—*Staffella* sp. *5*, Sagittal section; *6*, *7*, tangential sections; *8*, *9*, axial sections; all ×50 and all from Loc. T-42. (p. 159)

10, *11*—*Nankinella plummeri* Thompson, n. sp. Parallel axial section of a paratype magnified ×50 and ×20, respectively; from Loc. T-4. (p. 155)



Thompson, Pennsylvanian Fusulinids

UNIV. OF MICH.

associated with abundant *Millerella marblensis* Thompson, abundant *Staffella* sp., common *Eosuchubertella texana*, n. sp., and common *Profusulinella marblensis*, n. sp. Specimens are slightly more common near the top of the Marble Falls limestone on the northwest side of Rough Creek just west of the road crossing about 6½ miles west of Bend (Loc. T-104), where they are associated with abundant *Millerella* and common *Profusulinella marblensis*, n. sp., and on the bluffs of McAnnelly's Bend (Loc. T-105), where they are associated with common *Eosuchubertella texana*, n. sp., *Staffella expansa*, n. sp., and *Nankinella* sp.

TABLE OF MEASUREMENTS (IN MILLIMETERS) OF EOSCHUBERTELLA TEXANA

Specimen	L.	W.	Ratio	No. of volutions	Diam. of prol.	Height of volutions 1	2	3	4
1	0.61	0.52	1.2	3	.125	.044	.061	.099	—
2	—	0.61	—	4	.092	.041	.042	.080	.119
3	—	0.66	—	4	—	—	—	—	—
4	0.58	0.54	1.1	3	.092	.041	.065	.112	—
5	0.59	0.51	1.2	3	.108	.037	.061	.102	—
6	—	0.61	—	3	.099	.037	.075	.095	—
7	0.69	0.57	—	3	.084	.042	.076	.118	—

	Form ratio of volutions 1	2	3	Thickness of spirotheca 0	3	4
1	—	—	1.2	.010	.010	—
2	0.57	0.65	—	.007	—	.020
4	—	—	1.1	.009	.010	—
5	—	1.2	1.2	—	.010	—
6	—	—	—	—	.014	—
7	1.2	1.2	1.1	—	—	—

	Septal count 1	2	3	4	Tunnel angle (degrees) 2	3
3	—	12	16	17	—	—
4	8	—	—	—	—	—
5	8	—	—	—	24	32
6	6	9	11	—	—	—
7	—	—	—	—	—	70

EOSCHUBERTELLA TEXANA Thompson, n. sp.
Plate 31, figures 1–8

Shell minute, ellipsoidal, with rounded poles, irregular axis of coiling, broadly convex lateral slopes. Mature specimens of 3–4 volutions 0.58–0.69 mm. long, 0.51–0.66 mm. wide. Form ratio 1.1–1.2. In most specimens first 1–2 volutions coiled at large angle to axis of coiling of outer 2 volutions. First volution evolute, that is, does not embrace all of proloculum. Form ratios of first to third volution 0.57, 0.65–1.2, and 1.2, respectively.

Proloculum relatively large, outside diameter 92–125 microns, averaging 104 microns in 4 specimens. Shell loosely coiled. Average heights of chambers above tunnel of first to fourth volution in 4 specimens 41, 57, 98, and 119 microns, respectively. Heights of chambers essentially same throughout length of shell.

Spirotheca thin, composed of tectum and upper and lower tectoria. Thicknesses of spirotheca in third and fourth volution about 10 and 20 microns, respectively. Wall of proloculum about 8 microns thick, composed of a single dense layer. Spirotheca changes in thickness only slightly poleward from tunnel.

Septa thin, of essentially same structure as spirotheca. Average septal counts of first to fourth volution in 4 specimens about

8, 11, 14, and 17, respectively. Septa unfluted throughout length of shell. Septa essentially normal to spirotheca.

Tunnel relatively broad and high, path irregular in inner volutions, straight in outer 2 volutions. Tunnel angles of second and third volution about 24 and 32 degrees, respectively. Chomata low and highly asymmetrical. Tunnel side steep, poleward slope low and extends more than half distance to poles.

Remarks.—Eoschubertella texana, n. sp., resembles *E. gallowayi* (Skinner) from the Cherokee of Oklahoma and the Boggy formation of southern Oklahoma more closely than any other American form. They may be varieties of the same species. However, they can be distinguished by the larger size of *E. gallowayi* for corresponding volutions, the more massive and broader chomata of *E. texana*, and the more highly asymmetrical juvenile part of the shell of *E. texana*. The close similarity of these forms, from widely separated stratigraphic horizons, seems to emphasize the slow evolutionary development in the subfamily Schubertellinae.

Occurrence.—Eoschubertella texana is common in the Marble Falls limestone at the town of Chappel (Loc. T-41), on Middle Branch north side Honey Creek south of Llano (Loc. T-42), and in the upper 10 to 25 feet of the Marble Falls limestone at the north end of the limestone cliff on the west side of Colorado River at McAnnelly's Bend (Loc. T-105).

Eoschubertella spp.
Plate 31, figures 13–18

A number of minute specimens of *Eoschubertella* have been observed in collections from the Marble Falls limestone at Marble Falls (Loc. T-4), on Honey Creek 10 miles south of Llano (Loc. T-42), the region south of Bend on the Bend-Chisholm Camp road (Loc. T-97, T-98), and at McAnnelly's Bend (Loc. T-105). As the specimens are not well oriented, however, it is not possible to determine how many species are represented. Therefore, I hesitate to assign a specific name to any of them. For the sake of completeness, I am illustrating 6 specimens to show the variety of forms included in this reference.

Some specimens of about 4 volutions from the type section of the Marble Falls limestone and from the Marble Falls on Honey Creek measure 0.44 mm. in width, have 13 septa in the fourth volution, and have a minute proloculum with an outside diameter of slightly less than 50 microns. The inner 2 volutions of these specimens have an axis of coiling that is essentially normal to the axis of the outer volution, and they have small form ratios. Several other specimens from Honey Creek and from southeast of Bend on the Bend-Chisholm road have relatively massive chomata, highly asymmetrical early volutions, essentially spherical shells, and an outside diameter of about 0.40 mm.

Profusulinella marblensis
Thompson, n. sp.
Plate 31, figures 11, 12; Plate 32, figures 1–10

Shell minute, highly inflated fusiform to ellipsoidal, with pointed poles, straight axis of coiling, and convex lateral slopes. Mature specimens of 4½-5 volutions about 1.2 mm. long, 0.81–0.86 mm wide, form ratio about 1.3. Form ratios of first to fifth volution of holotype 1.3, 1.4, 1.4, 1.4, and 1.3, respectively. Thus shell retains essentially same shape throughout growth of individual.

Proloculum relatively large, outside diameter 68–119 microns, averaging 90 microns for 5 specimens. Chambers inflated, of essentially same height throughout length of shell. Average heights of chambers above tunnel in first to fifth volution of 6 specimens 35, 51, 75, 102, and 122 microns, respectively.

Spirotheca thin, composed of tectum and upper and lower tectoria. Thickness essentially same throughout length of shell. Average thicknesses of spirotheca in first to fifth volution of 4 specimens about 10, 15, 19, 19, and 17 microns, respectively.

Septa thin, of same structure as spirotheca. Septa unfluted throughout length of shell. Septa essentially normal to spirotheca. Average septal counts of first to fifth volution in 5 specimens 8, 12, 15, 20, and 27, respectively.

Tunnel broad, path essentially straight throughout shell. Tunnel angles in third to fifth volution of holotype about 30, 33, and

33 degrees, respectively. Chomata massive, about one-half as high as chambers and 3 times as wide as high. Tunnel side of chomata steep, poleward slope low.

Remarks.—*Profusulinella marblensis* is somewhat closely similar to *P. fittsi* (Thompson) from the lower part of the Atoka formation of Oklahoma. However, *P. fittsi* has more massive and broader chomata, more sharply pointed poles, and considerably different form ratio. An undescribed closely similar species of *Profusulinella* occurs in the Arrey formation of the lower Derryan in New Mexico and extreme western Texas.

Profusulinella marblensis, n. sp., is more or less intermediate in development between typical *Eoschubertella* and typical *Profusulinella*. However, its somewhat tightly coiled symmetrical shell and pointed poles suggest that it is more closely related biologically to the genotype of *Profusulinella*, *P. pararhomboides* Rauser-Cernussova and Beljaev, than to the genotype of *Eoschubertella*, *Schubertella lata* Lee and Chen.

Occurrence.—*Profusulinella marblensis* is abundant in the Marble Falls limestone on Middle Branch, north side Honey Creek, at cross-section survey about 10 miles south of Llano, Llano County (Loc. T-42), where it is associated with abundant *Millerella*, common *Nankinella plummeri*, n. sp., *Eoschubertella texana*, n. sp., *E.* sp., and abundant *Staffella* sp. It is common at the northwest corner of Chappel, San Saba County (Loc. T-41), associated with abundant *Staffella expansa*, n. sp., common *Nankinella plummeri*, n. sp., and rare *Eoschubertella texana*, n. sp. It is common in the upper few feet of the Marble Falls limestone at Rough Creek road crossing about 6½ miles west of Bend, San Saba County (Loc. T-104), associated with abundant *Millerella* and common *Pseudostaffella* aff. *P. needhami* Thompson.

TABLE OF MEASUREMENTS (IN MILLIMETERS) OF PROFUSULINELLA MARBLENSIS

Specimen	L.	W.	Ratio	No. of volutions	Diam. of prol.	Height of volutions 1	2	3	4	5
1	1.15	0.86	1.3	5	—	.037	.058	.078	.102	.136
2	—	0.57	—	4	.092	.034	.048	.078	.105	—
3	—	0.81	—	4½	.119	.027	.048	.071	.105	.122
4	—	0.81	—	5	.085	.027	.051	.061	.085	.108
5	—	0.76	—	5	.068	.037	.051	.071	—	—
7	—	0.56	—	3½	.085	.047	.047	.088	.112	—

	Form ratio of volutions 1	2	3	4	5	Thickness of spirotheca 1	2	3	4	5
1	1.3	1.4	1.4	1.4	1.3	—	.020	.020	.020	.017
2	—	—	—	—	—	.007	.017	.020	.014	—
3	—	—	—	—	—	—	.010	.017	.023	—
7	—	—	—	—	—	.014	.014	.017	—	—

	Septal count 1	2	3	4	5	Tunnel angle (degrees) 1	2	3	4	5
1	—	—	—	—	—	—	—	30	33	33
2	8	11	14	19	—	—	—	—	—	—
3	9	13	16	20	28	—	—	—	—	—
4	10	11	15	22	28	—	—	—	—	—
5	—	—	14	19	25	—	—	—	—	—
6	7	11	16	—	—	—	—	—	—	—
7	8	14	17	—	—	—	—	—	—	—

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NOMENCLATURAL SYNOPSIS OF SUPRASPECIFIC GROUPS OF THE FAMILY OSTREIDAE (PELECYPODA, MOLLUSCA)

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ABSTRACT—The names proposed for taxonomic groups of a rank higher than species and lower than family and subfamily in the family Ostreidae have been investigated. The validity and other pertinent nomenclatural data are given for each of these supraspecific taxonomic group names.

INTRODUCTION

IT IS obvious that an exact and well-defined terminology is indispensable to any scientific work. Thus anyone wanting to study a family of animals must first familiarize himself with the terminology to be used.

The terminology that is used in paleontologic work, and for that matter in most biologic work, is two-fold. First, there is the anatomical and morphological terminology comprising the precise and correct definition and use of such terms as ligament, resilifer, midumbonal line, and many other anatomical or morphological terms. Second, there is the taxonomic terminology comprising the precise and correct definition and use of taxonomic units such as genera and species and their subdivisions.

This taxonomic terminology is built up from two separate investigative approaches. One approach originates from the elucidation of the natural zoological kinships among the various groups under study. Of course, knowledge of this kinship cannot be obtained through mere classificatory or comparative morphological procedure but must be obtained from a combination of such procedure with the tracing of the paleontologic course of evolution as shown in the fossil record. The second approach leading to taxonomic terminology involves the careful application of the rules of nomenclature. Only by applying these rules carefully can we hope to arrive at a precise, correct, and stable taxonomic terminology. Nomenclature is a tool of taxonomy, and if used correctly it becomes an incisive precision tool that can be used with skill and finality.

It is the purpose of this paper to provide some correct and precise nomenclatural tools for future taxonomic, phylogenetic, and stratigraphic work in the family Ostreidae. This family has hitherto received very little serious taxonomic and phylogenetic investigation, although it is one of the most widespread and abundantly represented fossil groups of the Mesozoic and Cenozoic. Hence, it is highly desirable that a beginning be made.

It is customary to use only a few generic names in this family. To many authors the genera *Ostrea*, *Gryphaea*, *Exogyra*, and *Lopha* are sufficient. In contrast, there are authors who have proposed and used many new supraspecific group names. For instance, Vialov[1] in a four-page article proposed 27 new names. There are now 114 such names. However, many of these are objectionable, invalid, or superfluous from a purely nomenclatorial point of view. In the present paper all these names have been investigated, and an attempt has been made to clarify their nomenclatural status. Incidentally, many of the names have been found by the writer to be highly useful in defining and segregating evolutionary lines. Hence many of the names listed below will be used in future articles as nomenclatural tools for taxonomic, phylogenetic, and stratigraphic work.

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[1] Vialov, O. S., Sur la classification des huitres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n.s., vol. 4 (13), no .1 (105), pp. 17–20, 1936.

Chicago, Illinois, for information concerning *Sinostrea;* Dr. Leo G. Hertlein, San Francisco, California, for many letters on nomenclatural questions and publications; Dr. B. F. Howell, Princeton, New Jersey, for information concerning *Odontogryphaea* from Patagonia; Mr. W. E. Humphrey, Buenos Aires, Argentina, for information on and specimens of Patagonian oysters; Mr. M. C. Israelsky, Houston, Texas, for specimens of *Odontogryphaea thirsae* (Gabb) from Alabama; Dr. Myra Keen, Stanford University, California, for the loan of several oyster species; President Stanley King and Dr. F. B. Phleger, Amherst, Massachusetts, for the loan of Patagonian oysters; Miss Winnie McGlamery, University, Alabama, for information on and specimens of Alabama oysters; Mr. F. Stearns MacNeil, Dothan, Alabama, for information on and many specimens of Gulf Coastal Plain Tertiary oysters; Dr. J. Marwick, Wellington, New Zealand, for information on and specimens of New Zealand and Australia oysters; Dr. Norman D. Newell, New York, N. Y., for information concerning *Palaeostrea;* Mr. David Nicol, Stanford University, California, for several species of fossil oysters from California; Dr. A. A. Olsson, Gloversville, New York, for information on and the loan of Peruvian fossil oysters; Dr. Katherine V. W. Palmer, Ithaca, New York, for information concerning fossil species in the collection of the Paleontological Research Institute; Dr. G. G. Simpson and Dr. Otto H. Haas, New York, N. Y., for the loan of several fossil oyster species from the collections of the American Museum of Natural History; and Dr. Charles E. Weaver, Seattle, Washington, for information concerning Patagonian oysters. Dr. Hans E. Thalmann located the description of *Liostrea labrum* Vialov, which had been particularly troublesome to find. The writer gratefully acknowledges critical reading of the manuscript and many improvements suggested by Dr. Myra Keen and Mrs. H. J. Plummer.

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PROLEGOMENA

The term supraspecific used in this article is to be understood as embracing genera, subgenera, and sections, that is, taxonomic units of a rank higher than species and superspecies and lower than family and subfamily. The term supraspecific should not be confounded with superspecific. A superspecies is a monophyletic group of geographically representative (allopatric) species which are morphologically too distinct to be included in one species.[2] Supraspecific is derived from *supra,* above, and species; superspecific is derived from *super,* beyond.

No distinction is made here between genera, subgenera, and sections. They are accorded equal status as far as mere listing is concerned. This procedure has been adopted because it is the only one that is purely objective from the point of view of the nomenclator. To distinguish between them one needs to evaluate their taxonomic rank and position in a natural scheme of classification. Such an evaluation is beyond the scope of the present paper and is reserved for future study.

The nomenclatural terms used in this article have been restricted as much as possible and should be readily understood. If not, they may be found in publications by D. L. Frizzell[3] or Schenk and McMasters.[4]

The following letters are used as abbreviations and are placed in front of the nomenclatural units:

e—a misprint or an emendation of an earlier name, the latter superfluous in all cases discussed and without nomenclatural standing
h—a homonym of an earlier name; hence not available nomenclaturally
n—an invalid name
s—an exact synonym (=typonym) of an earlier valid and available name; hence needless
v—a valid name

The following letter combinations are abbreviations used in the text:

FD—first description of genotype species

[2] Mayr, Ernst, Systematics and the origin of species, p. 169, Columbia Univ. Press, 1942.

[3] Frizzell, D. L., Terminology of types: American Midland Naturalist, vol. 14, no. 6, pp. 637–668, 1933.

[4] Schenk, E. T., and McMasters, J. H., Procedure in taxonomy, Stanford Univ. Press, 1936.

GT—genotype species
SD—subsequent description of genotype species
TD—method of type designation
TL—geologic horizon and type locality of genotype species

The text below is divided into four parts; the first is an alphabetically arranged list of the supraspecific group names; the second an alphabetically arranged list of the authors responsible for these names; the third a chronological list of these names; and the fourth a listing of the exact synonyms and emendations of 6 groups.

The following alphabetical list gives all supraspecific group names of the family Ostreidae known to the writer. In addition several names are included that do not belong to this family but which at one time or another have been included in the Ostreidae or are pertinent from some other point of view. The list gives first the supraspecific group name, followed by the original author and publication proposing the name, then the genotype species (GT), quoted as written in the publication in which it is designated, next the method of genotype designation (TD), followed by the references to the first (FD) and subsequent (SD) descriptions of the genotype species, then followed by the geologic horizon and type locality (TL) of the genotype species. In some cases which present obvious difficulties or departures from current ideas a discussion of the nomenclatural procedure is added at the end.

Considerable effort has been expended in checking all data at first hand, and wherever possible the writer has not taken anyone's conclusions or statements for granted without checking all pertinent literature. All references have been seen and read personally unless they are indicated by "[Not seen]." The checking and careful reading of all original pertinent literature have presented great difficulties, because many of the older publications are rare and had to be located in and borrowed from distant libraries. However, this part of the work has been regarded as important because in many instances subsequent authors' statements are unreliable, and many facts of importance to nomenclatural procedure can be gathered only from original sources.

The geologic horizons and type localities of the genotype species have been obtained from original and subsequent descriptions of the species and have been brought up to date as far as possible.

References that are marked [Not seen] were obtained chiefly from Sherborn, C. D., Index animalium etc., sectio secunda, 1801 to 1850, 33 pts.: British Mus. Nat. Hist., 1922–1933, and Schulze, F. E., Kükenthal, W., & Heider, K., Nomenclator animalium generum et subgenerum: Preussische Akad. Wiss., 1926–1938.

Certain interpretations of nomenclatorial procedure adopted herein are subject to correction, because the procedures involved have not yet been settled fully.

One such procedure is based on the interpretation of Opinion 1 as annotated by Hemming, compare Opinions and Declarations rendered by the International Commission on Zoological Nomenclature, vol. 1, pt. 10, pp. 73–84, 1944. This concerns generic names proposed before December 31, 1930, without diagnosis or definition, or a bibliographic reference thereto, without the citation of an earlier name for which a new name is proposed, and without designation of a genotype species, but with one or more valid species included. Final decision on this Opinion will affect *Lopha* versus *Alectryonia*.

A second such procedure is based on the interpretation of Articles 25b ("that the author has applied the principles of binary nomenclature") and 27a ("when any part of the animal is named before the animal itself"). This concerns authors who established separate genera and species for the soft parts and the hard parts of a mollusk in the same publication. In such publications each mollusk species received two specific names each referred to a different genus. It is the writer's opinion that Article 27a does not apply in these cases, because these authors were conscious of the fact that they were applying 4 names (2 generic and 2 trivial ones) to the same species. As used here Article 27a applies only to those cases in which a part of the animal is named before the animal itself without complete knowledge of the animal by the author concerned. Final decision on this question will affect the status of the names proposed by Poli and Renier.

SUPRASPECIFIC GROUPS
ALPHABETICALLY ARRANGED

v—ABRUPTOLOPHA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 20, 1936.
GT: "*A. abrupta* d'Orb." TD: original.
FD: D'Orbigny, Alcide, Coquilles et Échinodermes fossiles de Colombie (Nouvelle-Grenade) recueillis de 1821 à 1833, par M. Boussingault, p. 59, pl. 6, figs. 4–6, 1842. Described as *Ostrea abrupta*, d'Orb., n. sp.
SD: Coquand, H., Monographie du genre Ostrea, Terrain Crétacé, pp. 175–176, pl. 63, figs. 1–3, 1869. [Figure of D'Orbigny's type specimen.] Redescribed as *Ostrea abrupta* D'Orbigny.
TL: Cretaceous on the banks of Rio Capitanejo, one of the branches of the Magdalena, at Cacota de Matanza and other localities in Colombia.

v—ACTINOSTREON (Bayle, E., Fossiles principaux des terrains: Explication de la carte géol. de la France, etc., vol. 4, atlas, pt. 1, pl. 132, figs. 2–6, 1878.)
Douvillé, [H.], Présentation de l'Atlas . . . par M. Bayle, etc.: Soc. géol. France, bull., ser. 3, vol. 7, pp. 91–92, 1879.
GT: "*Ostrea solitaria*, Sow." TD: by Douvillé, *op. cit.*
FD: Sowerby, J., Mineral Conchology of Great Britain; etc., vol. 5, p. 105, pl. 468, fig. 1, 1824. [Not seen]; *fide* Arkell. Described as *Ostrea solitaria* J. Sowerby, n. sp.
SD: Bayle, E., *op. cit.* Figured as *Actinostreon solitarium*. Sowerby, sp.
Arkell, W. J., A monograph of British Corallian Lamellibranchia, pt. 5: Palaeontograph. Soc., vol. 85, pp. 185–187, pl. 22, fig. 4, pl. 23, figs. 5–7, 1933. Redescribed as *Lopha solitaria* (J. Sowerby).
TL: Sequanian, Upper Jurassic, of Weymouth, England, according to Arkell.
Bayle introduced his new generic names, of which *Actinostreon* is one, without giving either a diagnosis or a definition or a description or a bibliographical reference of the new generic name. Neither did he give any hint which of the several species of the new genus was to be regarded as the genotype species. Under the circumstances his new generic name is not available nomenclaturally and must be rejected as a *nomen nudum*, compare discussion under Note 5, paragraph 8, on page 82 of Opinion 1, International Commission on Zoological Nomenclature, London, 1944, unless the Commission changes the published interpretation.
The generic name *Actinostreon* must therefore date from Douvillé, 1879, *op. cit.*, in whose work it is validly introduced with a genotype designation. Hence the correct quotation of the genus is *Actinostreon* Bayle in Douvillé, 1879.

n—ACUMINATA Arkell, W. J., The oysters of the Fuller's Earth, etc.: Cotteswold Naturalists' Field Club, Proc. 1933, vol. 25, pt. 1, p. 64, 1933 [1934].
GT: none.
Proposed as a "rationalised name" admittedly under disregard of the Rules and without definite unambiguous type designation, therefore not valid under Article 25c of the Rules.

v—ACUTOSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no 1. (105), p. 18, 1936.
GT: "*O. acutirustris* Nils." [Misprint for *acutirostris*.] TD: original.
FD: Nilsson, S. [Sven], Petrificata Suecana Formationis Cretaceae, pars 1 [only part published], p. 31, pl. 6, figs. 6A–6B, Londini Gothorum [Lund in Sweden], 1827.
SD: Hennig, Anders, Revision af Lamellibranchiaterna i Nilssons "Petrificata Suecana Formationis Cretaceae": Acta Univ. Lundensis [Lunds Univ. Ars-srk.], vol. 33, Andra Afd., pp. 11–14, pl. 1, figs. 15, 17, 21–23, 25–28, 1897. Included with and redescribed under *Ostrea incurva* Nilsson emend. Hennig.
TL: Quarries Ugnsmunnarna of the island Ifö, southern Sweden [type locality of *Ostrea acutirostris* Nilsson]. Zone of *Actinocamax mammillatus*, Campanian, Upper Cretaceous, according to Hägg, Richard, Die Mollusken und Brachiopoden der Schwedischen Kreide, I. Eriks-dal: Sveriges geol. undersökning, Avhand., ser. C, no. 363, Arsb. 23 (1929) N:o8, pp. 47–49, 1930.

v—AGEROSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 20, 1936.
GT: "*A. ungulata* Schloth." TD: original.
FD: Schlottheim, E. F. von, Beiträge zur Naturgeschichte der Versteinerungen in geognostischer Hinsicht: Taschenb. für die gesammte Min. etc. [C. C. Leonhard], Jahrg. [vol.] 7, p. 112, 1813. Contains no figure, no description, but the following reference "*Ostracites ungulatus*. Knorr P.II.I.T.D.VII.F.5.6. Petersberg."
TL: Maestrichtian, Upper Cretaceous, of Petersberg [Montagne St. Pierre] near Maestricht, Netherlands.
Although in later years the author of the species spelled his name Schlotheim it is Schlottheim in this publication.

v—AETOSTREON (Bayle, E., Fossiles principaux des terrains: Explication de la carte géol. de la France, etc., vol. 4, atlas, pt. 1, pl. 139, figs. 1–3, 1878.)
Douvillé, [H.], Présentation de l'Atlas . . . par M. Bayle, etc.: Soc. géol. France, bull., ser. 3, vol. 7, pp. 91–92, 1879.
GT: "*O. latissima*, Lam., =*O. aquila*, auct." TD: by Douvillé, *op. cit.*
FD: Lamarck, J. B. P. A. de, Histoire naturelle des animaux sans vertèbres, etc., [ed. 1], vol. 6, pt. 1, pp. 199, 1819. Described as *Gryphaea latissima* Lamarck, [*in parte*].

Cuvier, G., Recherches sur les ossemens fossiles, etc.; Chapt. 1: Description géologique des couches des environs de Paris, etc.: n. ed. [*i.e.* 2d ed.], vol. 2, pt. 2, pp. 332 and 614, pl. 9, figs. 11 A–B [not 11 C], 1822. Described as *Griphea Aquila* Brongniart, n. sp.
SD: Bayle, E., *op. cit.* Figured as *Aetostreon latissimum*. Lamarck, sp.
Pervinquière, Léon, *in* Palaeontologia universalis, ser. 3, fiche 194, 1910. Redescribed as *Gryphaea latissima* Lamarck.
TL: Lamarck's types have no localities indicated and the type locality of this species is unknown according to Pervinquière. Brongniart's type is from Anduze, Département Gard, southeastern France, according to Pervinquière. Bayle's figured specimens are from the Aptian, Lower Cretaceous, of Wassy, Haute-Marne, France. Occurs in the Albian and chiefly in the Aptian according to Pervinquière.

The correct quotation of the genus is *Aetostreon* Bayle in Douvillé, 1879, compare discussion under *Actinostreon*.

The genotype species has received several conflicting names, which were discussed carefully by Pervinquière. Pervinquière pointed out that Lamarck described *Gryphaea latissima* for the first time in 1801 [Lamarck, J. B., Système des animaux sans vertèbres, etc., p. 399, 1801]. Lamarck left two syntype specimens, one smaller and narrower, the other wider and larger, each obviously representing a separate species. However, in 1801 he neither figured nor gave a verbal description, but introduced the name *latissima* solely by reference to figures in an older publication. These are recognizable and refer to the same species as the smaller type specimen. Obviously the name *latissima* Lamarck, 1801, cannot be made to cover something that was not figured nor recognizable in any way from the original description. Hence the smaller type specimen becomes automatically the holotype of *latissima*, although Lamarck did not designate it a holotype, and herein one must disagree with Pervinquière's otherwise exemplary discussion. The larger and wider of the two type specimens of Lamarck, 1801, belongs to another species and forms the basis for Lamarck's later verbal description, i.e., the one of 1819. It is this larger species that was described by Brongniart in 1822 as *Griphea aquila*, n. sp. Hence, the correct name of the genotype species is *Aetostreon aquila* (Brongniart) and it is not the same species as *Gryphaea latissima* Lamarck, 1801.

v—ALECTRYONELLA Sacco, Federico, I molluschi dei terreni terziarii del Piemonte e della Liguria, vol. 23, p. 19, 1897.
GT: "*A. plicatula* (Gm. Lk.)" TD: original.
FD: Gmelin, J. F., Caroli a Linné systema naturae etc., ed. 13, p. 3336, 1792. [Not seen]; *teste* Myra Keen.
SD: Lamy, Ed., Notes sur les espèces Lamarckiennes d'Ostrea: Mus. Natl. hist. Nat. Bull., [ser. 1], vol. 30, p. 237–238, 1924.
Ranson, Gilbert, Observations sur quelques Ostréidés actuels et fossiles: Soc. géol. France Bull., ser. 5, vol. 13, p. 292, 1943. [Ranson states that *O. plicatula* Gmelin has been confounded with *Ostrea stentina* Payraudeau of the Mediterranean and does not occur in the Mediterranean.]
TL: Living in the East Indies, *fide* Lamy.

v—ALECTRYONIA Fischer, G. [de Waldheim], Museum Demidoff./ ou/ Catalogue systématique et raisonné des curiosités de la nature et de l'art./ données a l'Université Impériale de Moscou./ par Son Excellence/, Monsieur Paul de Demidoff./, vol. 3, pp. 269–270/ Moscou 1807.
GT: "*Ostrea cristagalli*, Linné". TD: subsequent by Stoliczka, F., Cretaceous fauna of southern India: Geol. Survey India, Palaeontologia Indica, ser. 6, vol. 3, pp. 454 and XXII, 1871.
FD: Linné, Carl, Systema naturae, 10th ed., p. 704, 1758. Described as *Mytilus cristagalli* L.
SD: Fischer, G. [de Waldheim], *op. cit.*, p. 269, 1807. Described as *Alectryonia rara* Fischer de Waldheim, n. sp.
TL: Living on Indo-Pacific coasts.

Fischer gave in the synonymy of his new species *Alectryonia rara* the following: "*Mytilus crista galli* Lin." The short description without illustration given by Fischer fits Linné's species, which Stoliczka evidently had in mind when he selected the type of the genus. *Lopha* has the same type species.

e—AMPHIDONTA Scudder, S., Nomenclator zoologicus, I.—Supplemental list of genera in zoology: U. S. Nat. Mus., Bull. 19, p. 17, 1882.

An emendation of *Amphidonte*. As such it is unnecessary and must be rejected according to Opinion 148. Also the mere listing of a name in a nomenclatural list does not impart validity to the name.

v—AMPHIDONTE Fischer de Waldheim, G., Sur les fossiles des corps organisés: Bull. Soc. Imp. des Naturalistes de Moscou, vol. 1, no. 2, pp. 31–32, pl. 1, figs. 1–4, 1829.
GT: "*A. Humboldti* Fischer" TD: subsequent by Vialov, O.S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 20, 1936.
FD: Fischer de Waldheim, G., *op. cit.* Described as *Amphidonte Humboldtii* Fischer de Waldheim, n. sp.
TL: Presumably Cretaceous of District of Bränsk, Gouvernement Orel, Russia.

v—ANGUSTOSTREA Vialov, O.S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., Comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 18, 1936.
GT: "*O. angusta* Desh." TD: original.
FD: Deshayes, G. P., Description des coquilles fossiles des environs de Paris, vol. 1, p. 362, pl. 58, figs. 1–3, 1824. Described as *Ostrea angusta* Deshayes, n. sp.
SD: Cossmann, M., Catalogue illustré des coquilles fossiles de l'Éocène des environs de

Paris etc.: Soc. Roy. Malacol. Belgique, Ann., vol. 22, fasc. 2, p. 196, 1887.
Cossmann, M., & Pissarro, G., Iconographie complète des coquilles fossiles de l'Éocène des environs de Paris, vol. 1, p. 43, figs. 135–18, 1904/06.
TL: Sparnacian, Lower Eocene, of Soissons, France.

v—ANODONTOSTREA Suter, Henry, Descriptions of new Tertiary Mollusca occurring in New Zealand, etc., pt. 1: New Zealand Geol. Surv., Pal. Bull. 5, p. 86, 1917.
GT: "*O. angasi* Sow." TD: subsequent by Finlay, H. J., The recent Mollusca of the Chatham Islands: New Zealand Inst. Trans. Proc., vol. 59, p. 264, 1928.
FD: Lamarck, J. B. P. A. de, Histoire naturelle des animaux sans vertèbres, [ed. 1], vol. 6, p. 208. Described as *Ostrea sinuata* Lamarck, n. sp.
SD: Sowerby, G. B., Jr., *in* Reeve, Lovell, Conchologia Iconica, or illustrations of the shells of molluscous animals, vol. 18, pl. 13, fig. 27 [erroneously numbered 28], 1871. [Not seen]; *teste* Myra Keen. Described as *Ostrea angassi* Sowerby, n.sp.
Suter, Henry, Manual of the New Zealand Mollusca, pp. 888–889, pl. 57, fig. 3, 1913. [Atlas published 1915].
Finlay, *op. cit.*, states that the following are synonyms of *O. sinuata* Lamk., 1819: *O. virescens* Angas, 1867, *O. angassi* Sow., 1871, *O. lutraria* Hutton, 1873.
TL: Living on coasts of Australia, Tasmania, New Zealand, and Chatham Islands.

v—ANULOSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), nol 1 (105), p. 19, 1936.
GT: "*O. Bourguignati* Coq." TD: original.
FD: Coquand, H., Monographie du genre Ostrea, Terrain Crétacé, pp. 86–87, pl. 21, figs. 7–12, pl. 38, figs. 15–19, 1869.
TL: Santonian, Upper Cretaceous, of R'fana near Tebessa, and subdivision of Sétif, Algeria, and St. Paterne and Villedieu, France.

v—ARCTOSTREA Pervinquière, Léon, Observations sur la nomenclature des Ostracés: Soc. géol. France, Bull., sér. 4, vol. 10, pp. 645–646, 1910.
GT: "*Ostrea carinata* Lamarck" TD: original.
FD: Lamarck, J. B. P. A. de, Mémoires sur les fossiles des environs de Paris: Ann. Mus. Hist. nat. [Paris], vol. 8, p. 166, 1806. [Not seen].
SD: Lamarck, J. B. P. A. de, Histoire naturelle des animaux sans vertèbres, etc., 1st ed., vol. 6, p. 216, 1819.
Pervinquière, Léon, *in* Palaeontologia universalis, ser. 3, fiche 197, 1910.
TL: Cenomanian, Upper Cretaceous, of St. Saturnin-Parigné-l'Evêque, Département de la Sarthe, France.

h—AVIA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 19, 1936.
GT: "*Gr. Costei* Coq." TD: original.
FD: Coquand, H., Monographie du genre Ostrea, Terrain Crétacé, p. 108, pl. 26, figs. 3–5, pl. 38, figs. 13–14, 1869. Described as *Ostrea Costei* Coquand, n. sp.
TL: Santonian, Upper Cretaceous, of the vicinity of Castellet, France.
Preoccupied by *Avia*, Navás, L., Insecta, Revue illustré d'Entomologie, Rennes, vol. 2, p. 75, 1912. [Not seen].

v—BELLOSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 17, 1936.
GT: "*O. bellovacina* Lam." TD: original.
FD: Lamarck, J. B. de, Mémoires sur les fossiles des environs de Paris: Ann. Mus. Hist. nat., vol. 8, p. 159, 1806 and vol. 14, pl. 25, figs. 1a+b, 1809. [Not seen].
SD: Deshayes, G. P., Description des coquilles fossiles des environs de Paris, vol. 1, pp. 356–358, pl. 48, figs. 1, 2; pl. 49, figs. 1, 2; pl. 50, fig. 6; pl. 55, figs. 1–3, 1824.
Deshayes, G. P., Descriptions des animaux sans vertèbres découverts dans le bassin de Paris, etc., vol. 2, pp. 117–118, 1864.
Cossmann, M., & Pissaro, G., Iconographie complète des coquilles fossiles de l'Éocène des environs de Paris, vol. 1, pl. 44, figs. 135–27, 1904/06. Figured as *Ostrea bellovacensis*, Lamk. *em.*
TL: Thanetian, Paleocene, of the vicinity of Beauvais, France.

v—BIAURIS Cossman, M., Synopsis illustré des mollusques de l'Éocène et de l'Oligocène en Aquitaine: Soc. géol. France, mem. 55, Paleont. vol. 24, pp. 211–212, 1922.
GT: "*Ostrea* (*Biauris*) *subhippopodium* [D'Archiac]." TD: monotypic.
FD: D'Archiac, M. A., Description des fossiles du groupe nummulitique recuillis . . . aux environs de Bayonne et de Dax: Soc. géol. France, mém., ser. 2, vol. 3, pt. 2, mem. 6, p. 439, pl. 13, figs. 4, 4a, 1850.
SD: Cossmann, M., *op. cit.*
TL: Trabay near St. Colombe, Dépt. Landes, France, according to D'Archiac; Bartonian, Upper Eocene, according to Cossmann.

e—BIAURUS Haas, F. [=Fritz], Bivalvia Teil II, 2.Lieferung: Dr. H. G. Bronns Klassen und Ordnungen des Tierreichs, Dritter Band Mollusca, 3.Abteilung, p. 294, 1938.
Misprint of *Biauris* Cossmann.

n—BILOBATA Arkell, W. J., The oysters of the Fuller's Earth: etc.: Cotteswold Naturalists' Field Club, Proc. 1933, vol. 25, pt. 1, p. 64, 1933 [1934].
Proposed as a "rationalised name" admittedly under disregard of the Rules and without definite unambiguous type designation, therefore not valid under Article 25c of the Rules.

v—CAMELEOLOPHA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 20, 1936.

GT: "*C. cameleo* Coq." TD: original.
FD: Coquand, H., Monographie du genre Ostrea, Terrain Crétacé, p. 149, pl. 54, figs. 1–17, 1869. Described as *Ostrea Cameleo* Coquand, n. sp.
TL: Cenomanian, Upper Cretaceous, of Bou Saada, Subdivision Sétif, Algeria.

v—CATINULA Rollier, Louis, Les faciès du Dogger ou Oolithique dans le Jura et les régions voisines: Mém. publié par la fondation Schnyder von Wartensee à Zurich, p. 272, 1911.
GT: "*Ostrea knorri* Voltz." TD: subsequent by Arkell, W. J., A monograph of British Corallian Lamellibranchia, pt. 4: Palaeontograph. Soc., vol. 84, pp. 149, 180, 1932.
FD: Voltz, P., Uebersicht der Petrefakten der beiden Rhein-Departemente *in* Aufschlager, J. F., Das Elsass, Supplement, p. 60, 1828. [Not seen]. Described as *Ostrea Knorrii* Voltz, n. sp.
This publication seems to be the same as: Schreiber, A., Anleitung für Reisende von den Quellen des Rheins bis Mainz, etc. . . . mit einer Zugabe einer Anleitung für Reisende im Elsasse von J. Fr. Aufschlager, August 1828. On p. 219 of this book is the following subtitle: Aufschlager, J. Fr., Das Elsass oder die Departemente des Ober- und Niederrheins.
SD: Arkell, W. J., The oysters of the Fuller's Earth: etc.: Cotteswold Naturalists' Field Club, Proc. 1933, vol. 25, pt. 1, pp. 21–68, pl. 2, figs. 6–27, 1933 [1934]. Redescribed as *Ostrea* (*"Catinula"*) *Knorrii* Voltz.
TL: From the Hauptrogenstein or *Parkinsonia parkinsoni* zone *sensu lato* (=in the main Upper Inferior Oolite), Jurassic, of the Wartenberg near Muttenz, about 4 miles southeast of Basel, Switzerland, according to Arkell.
Voltz, named this species *Ostrea Knorrii* and not *Knorri*. There is no reason to change the original spelling. However, *Ostrea Knorrii* Voltz, 1828, is preoccupied by *Ostrea Knorri* Defrance, 1821, in Dictionnaire des sciences naturelles, ed. 2, vol. 22, p. 27, which is an entirely different, Tertiary species. Therefore, *Ostrea Knorrii* Voltz must be suppressed as a later homonym. The next name available for this Jurassic species is *Ostrea gibriaci* Martin, 1863, Martin, J., Notes sur quelques fossiles nouveaux de l'étage Bathonien de la Côte-d'Or: Acad. Dijon Mém., ser. 2, vol. 10, pp. 57, 66–67, 69, pl. 5, figs. 16–17, 21, 24, 1863. [Not seen].

e—CATINULUS Lissajou, Marcel, Étude sur la faune du Bathonien des environs de Macon: Travaux du laboratoire de géol. de la Faculté des Sci. de Lyon, Fasc. 5, mém. 3, p. 142, 1923.
This is an emendation of *Catinula*. The emendation is unnecessary and rejected. Compare Opinion 148.

e—CERATOSTREA Haas, F. [=Fritz], Bivalvia Teil II, 2. Lieferung: Dr. H. G. Bronns Klassen und Ordnungen des Tierreichs, Dritter Band Mollusca, 3. Abteilung, p. 294, 1938.
Misprint of *Ceratostreon* Bayle.

v—CERATOSTREON (Bayle, E., Fossiles principaux des terrains: Explication de la carte géol. de la France, etc., vol. 4, atlas, pt. 1, pl. 134, figs. 1–2, 10–11, 1878.)
Douvillé, [H.], Présentation de l'Atlas . . . par M. Bayle, etc.: Soc. géol. France, bull., ser. 3, vol. 7, pp. 91–92, 1879.
GT: "*O. Matheroni*, d'Orb." TD: by Douvillé, *op. cit.*
FD: D'Orbigny, Alcide, Paléontologie Française, etc., Terrains Crétacés, vol. 3 (Lamell.), pp. 737–739, pl. 485, 1843–47 [1848]. As *Ostrea Matheroniana* D'Orbigny, n. sp.
SD: Bayle, E., *op. cit.* As *Ceratostreon Matheroni*. D'Orbigny, sp.
Douvillé and Bayle used *Matheroni* as the trivial name. There is no reason for a change from the original *Matheroniana* of D'Orbigny.
TL: Senonian of the west and south of France, several localities, among them environs of Saintes, Département Charente-Inférieure, Cognac, Dépt. Charente, and Tours, Dépt. Indre-et-Loire, according to D'Orbigny. Bayle's specimen came from the Maestrichtian, Upper Cretaceous, of Royan, Département Charente-Inférieure, France.
The correct quotation of the genus is *Ceratostreon* Bayle in Douvillé, 1879. See discussion under *Actinostreon*.

e—CIRCOGRAPHAEA Haas, F. [=Fritz], Bivalvia Teil II, 2. Lieferung: Dr. H. G. Bronns Klassen und Ordnungen des Tierreichs, Dritter Band Mollusca, 3. Abteilung, p. 294, 1938.
Misprint of *Circogryphaea* Vialov.

v—CIRCOGRYPHAEA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 19, 1936.
GT: "*Gr. Sinzowi* Netsch." TD: original.
FD: Netchaew, A. [Alexej Vasiljevic], Die Fauna der Eocänablagerungen an der Wolga unterhalb Saratow: Trudy Obshchestva Imp. Univ. Kazan, vol. 32, pt. 1, pp. 53–54, pl. 1, figs. 1a–c, 1897. [In Russian].
TL: Alexandrowskoye on the Volga, below the town of Kamyshin, southeastern Russia. According to Arkhanguelsky, A. D., Dépôts paléocènes de la région volgienne du gouvernement de Saratov et leur faune: [Russisch] Kaiserliche Mineralogische Gesellschaft, Materialien zur Geologie Russlands, vol. 22, Lief. 1, pp. 62–63, 1904, the species at the type locality is from the Upper Syzranian, which he correlates with the Thanetian, upper Paleocene.

v—COSTAGYRA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 20, 1936.
GT: "*E. olisiponensis* Scharpe" [misprint for Sharpe]. TD: original.
FD: Sharpe, Daniel, On the secondary district of Portugal which lies on the North of the Tagus: Quart. Jour. Geol. Soc. London, vol. 6, p. 185, pl. 19, figs. 1–2, 1850. Described as *Exogyra olisiponensis* Sharpe, n. sp.
SD: Choffat, Paul, Recueil d'études paléon-

tologiques sur la faune crétacique du Portugal, vol. 1, ser. 4, pp. 166–168, Ostreidae, pl. 6, figs. 17–19, : Comm. Serv. géol. Portugal, 1902.
TL: Upper Turonian, Upper Cretaceous, of Alcantara near Lisbon, Portugal.

v—CRASSOSTREA Sacco, Federico, I molluschi dei terreni terziarii del Piemonte e della Liguria, vol. 23, p. 15, 1897.
GT: "*C. virginiana* (Gmel.)" TD: original.
FD: Gmelin, J. F., Caroli a Linné systema naturae etc., ed. 13, vol. 1, pt. 6, p. 3336, 1792. Described as *Ostrea virginica* Gmelin, n. sp.
SD: McLean, R. A., The oysters of the western Atlantic: Acad. Nat. Sci. Philadelphia, Notulae naturae, no. 67, p. 8, pl. 1, figs. 1–4, 1941.
TL: Living on east and south coast of North America from Canada to Mexico.

v—CRENOSTREA Marwick, J., The Tertiary mollusca of the Gisborne district: New Zealand Geol. Surv., Pal. Bull. 13, p. 61, 1931.
GT: "*Ostrea wuellerstorfi* Zittel". TD: original.
FD: Zittel, K. A., Fossile Mollusken und Echinodermen: Palaontologie von Neu-Seeland, Beiträge zur Kenntniss der fossilen Flora und Fauna der Provinzen Auckland und Nelson; *in* Hochstetter, F. von, Reise der Oesterreichischen Fregatte "Novara" um die Erde in den Jahren 1857, 1858, 1859, etc.; Geol. Theil, Band 1, Abt. 2, pp. 54–55, pl. 11, fig. 6, 1864.
SD: Hutton, F. W., Catalogue of the Tertiary Mollusca and Echinodermata of New Zealand, in the collection of the Colonial Museum: Colonial Mus. and Geol. Surv. Dept., p. 34, 1873. [No illustration].
Harris, G. F., Catalogue of Tertiary Mollusca in the Department of Geology British Museum (Natural History), pt. 1, The Australasian Tertiary Mollusca, pp. 301–302, 1897. [No illustration].
Suter, Henry, Revision of the Tertiary Mollusca of New Zealand, based on type material, pt. 2: New Zealand Geol. Surv., Pal. Bull. 3, p. 53, pl. 7, fig. 3, 1915.
TL: Oligocene of north of Whaingaroa Harbor, Auckland Province, on west coast of North Island, New Zealand.
According to J. Marwick (letter dated Dec. 11, 1945) the age of the type locality is probably Duntroonian, that is, about Upper Oligocene.

n—CRETAGRYPHAEA Arkell, W. J., The oysters of the Fuller's Earth: etc.: Cotteswold Naturalists' Field Club, Proc. 1933, vol. 25, pt. 1, p. 62, 1933 [1934].
Proposed as a synonym of "*Pycnodonta* Fischer." Name not valid on account of lack of unambiguous type designation and definition of genus. In any case a synonym of *Pycnodonte*.

v—CUBITOSTREA Sacco, Federico, I molluschi dei terreni terziarii del Piemonte e della Liguria, vol. 23, p. 12, 1897.
GT: "*C. cubitus* (Desh.)" TD: original.
FD: Deshayes, G. P., Description des coquilles fossiles des environs de Paris, vol. 1, pp. 365–366, pl. 47, figs. 12–15, 1824 [1832].
SD: Cossmann, M., & Pissarro, G., Iconographie complète des coquilles fossiles de l'Éocène des environs de Paris, vol. 1, pl. 44, figs. 135–32, 1904/06.
TL: Auversian, Upper Eocene, of Senlis and Valmondois, France.

v—CURVOSTREA Vialov, O.S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 18, 1936.
GT: "*O. rediviva* Coq." TD: original.
FD: Coquand, H., Monographie du genre Ostrea, Terrain Crétacé, p. 154, pl. 42, figs. 8–11, pl. 54, figs. 18–30, 1869. Described as *Ostrea rediviva* Coquand, n. sp.
SD: Pervinquière, Léon, Études de Paléontologie Tunisienne, II, Gastropodes et Lamellibranches des terrains crétacés: Carte géol. Tunisie, p. 168, 1912. Regards *O. rediviva* Coquand the same as *O. Rouvillei* Coquand, which has priority.
TL: Cenomanian, Upper Cretaceous, of Saint-André near Gougargues, Dépt. Gard, France.

v—CYMBULOSTREA Sacco, Federico, I molluschi dei terreni terziarii del Piemonte e della Luguria, vol. 23, p. 12, 1897.
GT: "*Ostrea cymbula* Lk." TD: original.
FD: Lamarck, J. B. de, Mémoires sur les fossiles des environs de Paris: Ann. Mus. Hist. nat., vol. 8, p. 165, 1806. [Not seen].
SD: Deshayes, G. P., Description des coquilles fossiles des environs de Paris, vol. 1, pp. 367–368, pl. 53, figs. 2–4, pl. 57, fig. 8, 1824 [1832]. Cossmann, M., & Pissarro, G., Iconographie complète des coquilles fossiles de l'Éocène des environs de Paris, vol. 1, pl. 44, figs. 135–29, 1904/06.
TL: Lutetian, Middle Eocene, of Grignon near Paris, France.

v—DELTOIDEUM Rollier, Louis, Fossiles nouveaux ou peu connus des terrains secondaires (Mésozoïques) du Jura et des contrées environnantes: Soc. pal. Suisse Mém., vol. 42, pt. 6, p. 566, 1917.
GT: "*Ostrea* (*Liostrea*) *delta* Smith." TD: subsequent by Arkell (see reference below).
FD: Smith, William, Strata identified by organized fossils, p. 18, and Oak Tree Clay Plate, fig. 6, 1817. [Not seen].
SD: Arkell, W. J., A monograph of British Corallian Lamellibranchia, pt. 4: Palaeontograph. Soc., vol. 84, pp. 149–155, pl. 16, figs. 2–4; pl. 15, fig. 6; pl. 14, fig. 6; text figs. 22–26, 1932. Redescribed as *Ostrea* (*Liostrea*) *delta* Smith.
TL: From near the base of the Lower Kimeridge Clay at the foot of Shotover Hill, Oxford, England (type of Smith, 1817). Occurs in the Glos Oolite, Upper Calcareous Grit, and Kimeridge Clay, Corallian and Kimeridgian, Upper Jurassic, in England. Kimeridge is the ancient usage resurrected and preferred by Arkell over the more common Kimmeridge.
Arkell has shown that according to nomenclatural rules the "*Ostrea* (*Deltoideum*) *Sowerbyana* Bronn" of Rollier should go under the specific name of *delta* Smith.

e—DENDOSTRAEA Sowerby, G. B., Jr., A conchological manual, [ed. 1], pp. 38, 75, London, 1839.

This name is an emendation of *Dendostrea* Swainson; it is faulty and must be rejected.

v—DENDOSTREA Swainson, W., The elements of modern Conchology: briefly and plainly stated, for the use of students and travellers, p. 39, London, 1835.
GT: "*Ostrea folium* Linn." TD: subsequent by Herrmannsen, A. N., Indicis generum malacozoorum primordia, vol. 1, p. 378, 1846.

This generic name was proposed originally without mention, by name, of any species belonging to the genus in the following manner:
"191. DENDOSTREA. *Sw.* More convex; substance nearly solid; valves with the margins plaited, and clasping into each other. *Tree Oysters.*"

Accordingly the first species published in connection with the genus become available as types; compare Opinion 46 fifth category. The first species were published by Sowerby, G. B., Jr., A conchological manual, [ed. 1], p. 38, London, 1839, in the following manner:
"DENDOSTRAEA. Sw. (*Δενδρον dendron*, tree; *ὀστρεον ostreon*, oyster.) Ostraea *Crista-galli*, and other species which are attached to stems of seaweed and corallines, by means of arms thrown out from the outer surface of the lower valve. Fig. 181, Ostraea Folium."

Dendostrea and its emendations must all take the same genotype species.

e—DENDROSTRAEA Swainson, William, A treatise on malacology, or shells and shell-fish, p. 389, 1840.

This name is an emendation of *Dendostrea* Swainson, 1835. The emendation is faulty and must be rejected.

e—DENDROSTREA Agassiz, L. [Louis], Nomenclator zoologicus, etc., index universalis, pp. 118, 119, 1846.

This name is an emendation of *Dendostrea* Swainson. As an emendation it is correctly formed but must be suppressed.

n—DILATATA Arkell, W. J., The oysters of the Fuller's Earth: etc.: Cotteswold Naturalists' Field Club, Proc. 1933, vol. 25, pt. 1, p. 64, 1933 [1934].

Proposed as a "rationalised name" admittedly under disregard of the Rules and without definite unambiguous designation of type; therefore not valid under Article 25c of the Rules.

s—DIOECIOSTREA Orton, J. H., The dominant species of Ostrea: Nature, vol. 121, pp. 320–321, 1928.
GT: "*Dioeciostrea americana* Orton = *O. virginica*." TD: herewith designated.

This new name is an exact synonym of *Crassostrea* Sacco, 1897, because both have the same genotype species, *Ostrea virginica* Gmelin.

v—ENANTIOSTREON Bittner, A., Lamellibranchiaten aus der Trias des Bakonyer Waldes: Resultate der wiss. Erforschung des Balatonsees, vol. 1, pt. 1, Anhang, Palaeontologie der Umgebung des Balatonsees, vol. 2, Abh. 3, p. 72, 1901.

This is not an ostreid genus.

v—EOSTREA von Ihering, H., Les mollusques fossiles du Tertiaire et du Crétacé supérieur de l'Argentine: Anales Mus. Nac. Buenos Aires, ser. 3, vol. 7, [vol. 14], p. 42, 1907.
GT: "*Ostrea puelchana* Orbigny." TD: subsequent by Iredale, Tom, Mollusca, pt. 1: Great Barrier Reef Expedition 1928–29, Sci. repts., vol. 5, no. 6, p. 394, British Mus. (Nat. History), 1939.
FD: D'Orbigny, A., Voyage dans l'Amérique méridionale etc. exécuté pendant 1826–33, Moll., p. 672, pl. 85, figs. 25–26, 1841. [Not seen].
TL: East coast of South America, living, *fide* Ihering.

s—EUOSTREA Jaworski, E., Beiträge zur Stammesgeschichte der Austern: Zeitschr. indukt. Abstammungs und Vererbungslehre, vol. 9, pp. 192–215, 1913.
GT: "*Crassostrea* (*Euostrea*) *virginica* (Lamarck) = *Ostrea virginica* Gmelin" TD: herewith designated.

The "*Crass.* (*Euostrea*) *virginica* Lam." of Jaworski is the same as *Ostrea virginica* Gmelin. Hence *Euostrea* is an exact synonym of *Crassostrea* Sacco, 1897, and must be dropped in favor of the latter.

v—EXOGYRA Say, Thomas, Observations on some species of zoophytes, shells, etc. principally fossil: Am. Jour. Sci. Arts, [ser. 1], vol. 2, no. 2, p. 43, 1820.
GT: "*E. costata.*" TD: monotypic.
FD: Say, Thomas, *op. cit.* [No illustration].
SD: Stephenson, L. W., Species of *Exogyra* from the eastern Gulf region and the Carolinas: U. S. Geol. Survey, Prof. Paper 81, pp. 41–55, pl. 16, figs. 3–4, pls. 17–18, pl. 19, figs. 3–4, 1914.
TL: Maestrichtian, Upper Cretaceous, of New Jersey, U.S.A.

v—FATINA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptres rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 19, 1936.
GT: "*Gr. beldersaiensis* Gor." TD: original.
FD: Gorizdro, Z. [F.], Materials for the study of Fauna of the tertiary formations in Turkestan: Soc. Imp. des naturalistes de Petrograd Trav., sect. Géol. Min., vol. 37, livr. 5, pp. 22 and 52, pl. 1, figs. 1, 2, 1915.
SD: Vialov, O. S., On the middle-Asiatic *Fatina* Vial. and *Turkostrea* Vial.: Acad. Sci. U.R.S.S., bull., cl. sci. math. nat., sér. géol., no. 1, pp. 15–18, 1938. [Russian with English summary].
TL: Turkestanian, equivalent of upper Lutetian and Auversian, middle Eocene, of "banks of the mountain stream Belder-Sai, which takes its rise among the peaks of the Great Chimgan, and subsequently unites with the river Aksa-

Gata, the left tributary of the river Chirchik," eastern part of Taschkent district, Turkestan.

v—FERGANEA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 19, 1936.
GT: "*Gr. Severzowi* Rom." TD: original.
FD: Romanovski, G. D., Protocol 7: Russ. K. min. Gesell. St. Petersburg Verh., ser. 2, vol. 18, p. 251, 1883. [In Russian]. Described as *Gryphaea Sewerzowii* Romanovski, n. sp., without illustration.
SD: Romanowski, G. D., Materials to the geology of Turkestan, vol. 2, pp. 54–55, pl. 12, figs. 1–3, 1884. [In Russian].
Vialov, O. S., On the middle-Asiatic *Fatina* Vial. and *Turkostrea* Vial.: Acad. Sci. U.R.S.S., bull., cl. sci. math. nat., sér. géol., no. 1, pp. 15–18, 1938. [Russian with English summary].
TL: "in the same arenaceous-argillaceous deposit of the Fergana stage, in which *Ostrea Tianschanensis* was found" Romanowski, p. 55. Soumsarian stage, Fergana group, Oligocene.

v—FLEMINGOSTREA Vredenburg, E. W., *Flemingostrea*, an eastern group of Upper Cretaceous and Eocene Ostreidae: etc.: Geol. Surv. India, Rec., vol. 47, pt. 3, pp. 196–203, pls. 17–20, 1916.
GT: "*Ostrea* (*Flemingostrea*) *Flemingi* d'Archiac and Haime." TD: original.
FD: d'Archiac, [E. J. A.], & Haims, Jules, Description des animaux fossiles du groupe nummulitique de l'Inde etc., p. 275, pl. 23, figs. 14–15, Paris, 1853.
SD: Vredenburg, E. W., *op. cit.*, pp. 201–202, pl. 20, figs. 1–7.
TL: Laki series, Lower Eocene, of the Salt Range, India.

v—FLUCTOGYRA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 20, 1936.
GT: "*Ex. Trigeri* Coq." TD: original.
FD: Coquand, H., Monographie du genre Ostrea, Terrain Crétacé, pp. 119–120, pl. 51, figs. 1–2, 1869. Described as *Ostrea Trigeri* Coquand, n. sp.
TL: Cenomanian, Upper Cretaceous, of the vicinity of le Mans, France.

v—GIGANTOSTREA Sacco, Federico, I molluschi dei terreni terziarii del Piemonte e della Liguria, vol. 23, p. 14, 1897.
GT: "*G. gigantica* (Sol.)" TD: original.
FD: Solander, D. C., Fossilia Hantoniensia, collecta et in Musaeo Britannico deposita a Gustavo Brander, p. 36, pl. 8, fig. 88, 1766. [Not seen].
SD: Cox, L. R., Fossiles Éocène du nord de l'Afghanistan: Soc. géol. France, Mém. 39, n. s., vol. 17, fasc. 1, pp. 40–41, 1938.
TL: Bartonian, Upper Eocene, of Barton, Hampshire, England.

e—GORIDZELLA Haas, F. [=Fritz], Bivalvia Teil II, 2. Lieferung: Dr. H. G. Bronns Klassen und Ordnungen des Tierreichs, Dritter Band Mollusca, 3. Abteilung, p. 294, 1938.
Misprint of *Gorizdrella* Vialov.

v—GORIZDRELLA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 17, 1936.
GT: "*O. gorizdroae* Vial." TD: original.
TL: Allaïan stage, Fergana group, lower Lutetian, Middle Eocene. Exact type locality unknown.
A formal description of the genotype species has not been found; probably such a description is yet to be published. In order that *Gorizdrella* may be regarded as validly proposed, it is assumed that the definition given for it by Vialov in 1936 is also sufficient to define the sole species of *Gorizdrella*. Under this assumption both date from 1936. Compare discussion under *Labrostrea*.

e—GRIPHAEA Blainville, H. M., *in* Dictionnaire des sciences naturelles . . . , publié par les professeurs du Jardin du Roi et les principales écoles de Paris et rédigé par Cuvier, [ed. 2], vol. 19, p. 533, 1821.
An emendation or misprint of *Gryphaea*, must be suppressed as a homonym according to Opinion 147.

v—GRYPHAEA Lamarck, J. B., Système des animaux sans vertèbres, etc., pp. 398–399, 1801.
GT: "*Gryphaea arcuata* Lam." TD: subsequent by Anton, H. E., Verzeichniss der Conchylien, etc., p. 21, 1839 [1838]. (Privately printed in Halle, Germany.) [Not seen]; *teste* Myra Keen.
FD: Lamarck, J. B., *op. cit.*, p. 398.
SD: Bayle, E., Fossiles principaux des terrains: Explication de la carte géol. de la France, etc., vol. 4, atlas, pt. 1, pl. 126, figs. 3–5, 1878. Figured as *Gryphaea gryphus*. Linné, sp. Schäfle, Ludwig, Ueber Lias- und Doggeraustern: Geol. Pal. Abhand., N. F., vol. 17 (21), Heft 2, pp. 26–37, pl. 2 (10), figs. 7–17; pl. 3 (11), figs. 1–4, 9, 1929.
TL: Liassic of western Europe.
Gryphaea was first described and named by Lamarck in January 1801 (*op. cit.*). There the new genus was defined and 9 species were given in the following sequence: *angulata*, *suborbiculata*, *cymbula*, *arcuata*, *africana*, *carinata*, *latissima*, *depressa*, *angustata*. None of these species was figured or described, but 6 of them were clearly defined by references to figures in previously published works. These 6 are: *suborbiculata*, *cymbula*, *arcuata*, *africana*, *carinata*, *latissima*. The 3 which were not defined, described, or indicated were obviously *nomina nuda* as far as Lamarck's publication of January 1801 was concerned. That was clearly stated by Lamarck himself in these words: "Dans mon tableau général des espèces, je caractérisai toutes celles dont je donne ici simplement le nom" [. . . I shall characterize all those species, of which I have given here simply the name, p. 399]. This is a clear statement that the three species are *nomina nuda* and will be described at a future date. Among

these *nomina nuda* was *Gryphaea angulata*, which was mentioned by Lamarck in 1801 as follows: "Gryphaea angulata. n. Espèce rarissime que l'on possède dans l'état marin, à Paris."

Many authors regard this species as the genotype species of *Gryphaea*. This is, however, not possible under the International Rules of Zoological Nomenclature. *Nomina nuda* are not valid species and invalid species cannot be selected as type species. The genotype species can be selected solely from the original list of valid species as of Lamarck, January, 1801. Whether the three invalid species were at a later date validated or not is immaterial to the selection of a type species for *Gryphaea* Lamarck, January, 1801.

The only other species which already has been selected as a type of the genus is *Gryphaea arcuata* Lamarck. The first author known to have selected this species is H. E. Anton (*op. cit.*).

Dall, W. H., Contributions to the Tertiary fauna of Florida, etc.: Wagner Free Inst. Sci. Philadelphia Trans., vol. 3, pt. 4, pp. 672–675, 1898, was the first to discuss the question of the type species of this genus and to apply the nomenclattral rules thoroughly. Later the same question was treated by Hertlein, L. G., A new gryphaeoid oyster from the Eocene of California: San Diego Soc. Nat. Hist. Trans., vol. 7, no. 22, pp. 277–278, 1933. These two authors have come to the same conclusion, which is also shared here.

n—GRYPHAEIGENUS Renier, S. A., Tavole per servire alla Classificazione e Connoscenza degli Animali, Padova, tabell 7, 1807. [Not seen].

According to Tom Iredale the classification scheme of Renier was similar to that of Poli. Renier gave separate generic names to the soft parts and to the shell of the animal. As such a scheme is not binominal it is to be rejected. Compare Iredale, Tom, Book notes: Malacol. Soc. London, Proc., vol. 15, pp. 78–92, 1922.

v—GRYPHAEOSTREA Conrad, T. A., Catalogue of the Eocene and Oligocene Testacea of the United States: Am. Jour. Conchol., vol. 1, no. 1, p. 15, February 25, 1865; and no. 2, unnumbered page following p. 190, April 15, 1865.
GT: "*Ostrea eversa*, Deshayes." TD: monotypic.
FD: Melleville, M., Mémoire sur les sables tertiaires inférieurs de Paris, etc.: Annales Sci. géol. etc. M. A. Rivière, année 2, no. 2, p. 87, pl. 3, figs. 3–4, 1843. Described as *Gryphaea eversa* Melleville, n. sp.
SD: Deshayes, G. P., Description des animaux sans vertèbres découverts dans le bassin de Paris etc., vol. 2, pp. 99–100, pl. 84, figs. 5–8, 1864. Redescribed as *Ostrea eversa*, d'Orb.
TL: Thanetian, Paleocene, of Cormicy, Villers-Franqueux, and other localities in France.

This name was printed *Gryphoeostrea* on p. 15, but this misprint was corrected under "Corrections" on the unnumbered page following p. 190 of the same volume, April 15, 1865, to *Gryphaeostrea*. The genus was originally proposed on February 25, 1865, on p. 15 as follows: "Subgenus, GRYPHOEOSTREA, Conrad./ O. SUBEVERSA, C.—Amer. Jour. Conch., 1865. U. Marlboro', Maryland." The name *subeversa* Conrad listed above was obviously a *nomen nudum*, because no description or figure were given. Also the new subgenus was proposed without any definition or description or any other clarifying comment. Therefore, the new subgenus was not validly proposed on February 25, 1865. However, on April 15, 1865, Conrad published the following correction: "The species *subeversa* is probably identical with *Ostrea eversa*, Deshayes." This sentence means that *Ostrea eversa* is also a member of the subgenus *Gryphaeostrea*, whether it be identical with *subeversa* or not. On that date then *Gryphaeostrea* included *eversa*, a valid and well-known species, and *subeversa*, a *nomen nudum*. Hereby *eversa* became the monotype of *Gryphaeostrea*, because it was the only valid species assigned to the new subgenus, and simultaneously *Gryphaeostrea* became a valid name under Article 25 and Opinion 1 of the Rules.

e—GRYPHEA Risso, A., Histoire naturelle de principales productions de l'Europe meridionale etc., vol. 4, p. 290, 1826. [Not seen].

An emendation of *Gryphaea*, must be suppressed as a homonym according to Opinion 147.

s—GRYPHITES Schlottheim, E. F. von, Beiträge zur Naturgeschichte der Versteinerungen in geognostischer Hinsicht: Taschenbuch für die gesammte Mineralogie etc., K. C. von Leonhard, Jahrg. 7, Abt. 1, pp. 50–52, etc., 1813.
GT: "*Gryphites cimbium* Schlottheim = *Gryphaea arcuata* Lamarck." TD: herewith designated.

Although in later years the author of the species spelled his name Schlotheim it is Schlottheim in this publication.

Gryphites was originally a pre-Linnean, that is, pre-1758, name. As such it is not valid in modern nomenclature, which dates from January 1, 1758. However, Schlottheim used it as a generic name in connection with several new species he established in 1813. Thereby he gave the name *Gryphites* his approval and made it available as dating from 1813. Nevertheless there is some doubt whether *Gryphites* Schlottheim, 1813, fulfills all requirements for validity contained in Article 25. Schlottheim did not give a definition or description of the genus *Gryphites* anywhere in his article of 1813 nor did he give any indication which of the several species is the genotype. Under these circumstances the name *Gryphites* would not fulfill the conditions of Article 25 and would remain invalid, were it not that he gave under his species synonymies references to pre-1758 publications. One of the publications referred to is Linné, Carl, Museum Tessinianum, 1753. These publications are inaccessible to the present writer, but presumably one of them contains a good definition or description of *Gryphites*. The writer is somewhat in doubt whether such

a reference given by Schlottheim under species synonymy can be regarded as a reference to the genus too, but assumes that this procedure is possible. In that case *Gryphites* Schlottheim, 1813, would have a description or definition through reference to previous literature and would be valid under Article 25 and Opinion 5. The next question is what is its type species? This must be sought among the several original species listed in Schlottheim's article. Apparently no genotype species has been selected by a subsequent author so far.

Gryphites cimbium Schlottheim, 1813, p. 74, is herewith designated the genotype species. This species was neither described nor figured by Schlottheim in 1813 but was validated by him through literature references, among which was "Bourg. T. XV, F. 92." This is apparently the same reference that Lamarck used to validate *Gryphaea arcuata* Lamarck, n. sp., in 1801. Consequently *Gryphaea arcuata* Lamarck is identical with *Gryphites cimbium* Schlottheim, 1813, as is generally conceded among European paleontologists. Therefore, *Gryphites*, 1813, is a later exact synonym of *Gryphaea*, 1801.

e—GRYPHOEA Bosc, L. A. G., Histoire naturelle des coquilles, etc., vol. 2, pp. 307, 310, 1802. [Not seen].

An emendation of *Gryphaea*, must be suppressed according to Opinion 147.

e—GRYPHOEOSTREA Conrad, T. A., Catalogue of the Eocene and Oligocene Testacea of the United States: Amer. Jour. Conch., vol. 1, no. 1, p. 15, February 25, 1865.

Misprint for *Gryphaeostrea*, corrected under "Corrections" on unnumbered page following p. 190 of the same volume, April 15, 1865. See *Gryphaeostrea*.

e—GRYPHOSTREA Haas, F. [=Fritz], Bivalvia Teil II, 2. Lieferung: Dr. G. H. Bronns Klassen und Ordnungen des Tierreichs, Dritter Band Mollusca, 3. Abteilung, p. 294, 1938.

Misprint of *Gryphaeostrea* Conrad.

v—HETEROSTREA Jaworski, E., Beiträge zur Stammesgeschichte der Austern: Zeitschr. indukt. Abstammungs und Vererbungslehre, vol. 9, pp. 192–195, pls. 6–7, 1913.
GT: "*Crassostrea* (*Heterostrea*) *Steinmanni* Jaw." TD: monotypic.
FD: Jaworski, E., *op. cit.*
TL: Middle Dogger Sauzei-beds, Upper Jurassic, of Chunumayao, Dept. Huancavelica, Prov. Angaraes, northern Peru.

n—INCURVA Arkell, W. J., The oysters of the Fuller's Earth: etc.: Cotteswold Naturalists' Field Club, Proc. 1933, vol. 25, pt. 1, p. 64, 1933 [1934].
GT: none.

Proposed as a "rationalised name" admittedly under disregard of the Rules and without definite unambiguous designation of type; therefore not valid under Article 25c of the Rules.

n—JUROGRYPHAEA Arkell, W. J., The oysters of the Fuller's Earth: etc.: Cotteswold Naturalists' Field Club, Proc. 1933, vol. 25, pt. 1, p. 62, 1933 [1934].
GT: none.

Proposed without summary of characters and without any designation of the type species, therefore invalid.

n—KNORRII Arkell, W. J., The oysters of the Fuller's Earth: etc.: Cotteswold Naturalists' Field Club, Proc. 1933, vol. 25, pt. 1, p. 64, 1933 [1934].

Proposed as a "rationalised name" admittedly under disregard of the Rules and without definite unambiguous designation of the type; therefore not valid under Article 25c of the Rules.

v—KOKANOSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 19, 1936.
GT: "*O. kokanensis* Sok." TD: original.
FD: Sokolov, D. W., La question de l'étage Ferganien: Soc. Imp. des Naturalistes de Moscou bull., n. s., vol. 23, pp. 73–75, figs. 7a–c, 1909 [1910].
SD: Böhm, Johannes, Die palaeogene Fauna Ost-Turkestans: Deutsche geol. Gesell. Zeitschr., vol. 85, pp. 110–111, pl. 10, figs. 2a–b, 1934.
TL: In whitish limestone, 5 meters thick, in lower part of greenish marl sequence, which composes the middle subdivision of the Fergana group, according to Sokolov. Turkestanian stage, Fergana group, equivalent to upper Lutetian and Auversian, Middle Eocene, according to Vialov. Exact type locality apparently not given.

v—LABROSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 18, 1936.
GT: "*O. labrum* Vial." TD: original.
FD: Vialov, O. S., New oysters from the Palaeogene of the Trans-Caspian region: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 48, no. 3, pp. 200–201, 1945.
TL: Paleogene of Tuar-Kyr, section 18 at the Djakyr spring, Trans-Caspian region.

When Vialov proposed *Labrostrea* in 1936, the genotype and only species had not yet been described; the first formal description of this species appeared in 1945. One might maintain that *Liostrea* (*Labrostrea*) *labrum* Vialov was a *nomen nudum* in 1936; hence the section *Labrostrea* was not validly proposed in 1936. In that case *Labrostrea* would date from 1945 only. However, one can also regard the definition of *Labrostrea* as sufficient to cover its sole species *labrum* too in the same way as the description of the genotype species is regarded as sufficient to cover a monotypic genus. In that case both *Labrostrea* and *labrum* are regarded as validly proposed and dating from 1936. For the sake of simplicity the latter course is adopted here.

n—LIMNOSTRACITES Herrmannsen, A. N., Indicis generum Malacozoorum primordia, vol. 1, fasc. 5, p. 606, 1846 [1847].

Merely listed as a pre-Linnean term without giving it any nomenclatural standing.

s—LIOGRYPHAEA Fischer, Paul, Manuel de Conchyliologie et de Paléontologie conchyliologique ou histoire naturelle des mollusques vivants et fossiles etc., p. 927, 1886.
GT: "*G. arcuata*, Lamarck." TD: monotypic.

Liogryphaea is an exact synonym of *Gryphaea* and must be suppressed in favor of the latter.

v—LIOSTREA Douvillé, Henri, Mollusques fossiles; Études géologiques *in* Morgan, J. de, Mission scientifique en Perse par J. de Morgan, vol. 3, pt. 4 (Paléontologie), p. 273, Paris 1904. Douvillé, Henri, Les explorations de M. de Morgan en Perse: Soc. géol. France Bull., ser. 4, vol. 4, p. 546, 1904.
GT: "*L. lamellosa*" [error for *L. sublamellosa*].
TD: original.
FD: Dunker, Wilh., Ueber die in dem Lias bei Halberstadt vorkommenden Versteinerungen: Palaeontographica, [ser. 1], vol. 1, lief. 1, p. 41, pl. 6, figs. 27–30, 1846. Described as *Ostrea sublamellosa* Dunker, n. sp.

According to L. R. Cox *Liostrea sublamellosa* (Dunker), 1846, is regarded as identical with *L. liassica* (Strickland), 1844. *L. hagenowi* (Nilsson) refers to the same species top. Strickland, H. E., *in* Murchison, R. I., Outline of the geology of Cheltenham, ed. 2, p. 99, 18444. Not seen.
TL: Liassic of Halberstadt, Germany.

In the first cited publication the genotype species was erroneously given as *O. lamellosa*. This lapsus was corrected in the second article in the same year.

s—LOPHA Bolten, J. F., [or Roeding, P. F.], Museum Boltenianum sive catalogus cimeliorum e tribus regnis naturae, pt. 2; pp. 168–169, Hamburg 1798.
GT: "*Ostrea crista-galli* Linné." TD: subsequent by Dall, W. H., Contributions to the Tertiary fauna of Florida, etc.: Wagner Free Inst. Sci. Philadelphia Trans., vol. 3, pt. 4, p. 672, 1898.
FD: Linné, Carl, Systema naturae, 10th ed., p. 704, 1758. Described as *Mytilus crista galli* Linné, n. sp.
TL: Living on Indo-Pacific coasts.

Although many authors have accepted *Lopha* in recent years, *Lopha* can not be used as dating from 1798. The name was proposed in 1798 without a definition, description, or indication as the heading of a list of several species in the following manner: "*Lopha* Der Hahnenkamm" [*Lopha* The cock's comb]. Among the several valid species listed there is none that is cited or designated as the type. Also, there is no case of absolute tautonymy, although the first species listed under *Lopha* is listed as follows: "*L. Crista Galli* Der Hahnenkamm." This can be interpreted only as virtual tautonymy and not as a type designation. That leaves the generic name invalid according to Opinion 1 and Article 25, unless the Commission changes the published interpretation. *Lopha* is available only from the date of the first subsequent type designation or the first definition, description, or indication of the generic name. Apparently no such procedure was proposed before 1807, hence *Alectryonia* became valid before *Lopha*, and the latter became a later exact synonym of *Alectryonia*.

Compare also Winckworth, R., The types of the Boltenian genera: Proc. Malacol. Soc. London, vol. 26, pts. 4 and 5, p. 141, 1945.

n—MARCOUI Arkell, W. J., The oysters of the Fuller's Earth: etc.: Cotteswold Naturalists' Field Club, Proc. 1933, vol. 25, pt. 1, p. 64, 1933 [1934].
GT: None.

Proposed as a "rationalised name" admittedly under disregard of the Rules and without definite unambiguous designation of the type, therefore not valid.

v—MARGOSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 20, 1936.
GT: "*M. Merceyi* Coq." TD: original.
FD: Coquand, H., Monographie du genre Ostrea, Terrain Crétacé, pp. 93–94, pl. 28, fig. 22, pl., 29, figs. 8–14, 1869. Described as *Ostrea Merceyi* Coquand, n. sp.
TL: *Micraster coranguinum* zone of the Santonian, Upper Cretaceous, of Tartigny, Dépt. Oise, France.

v—MIMETOSTREON Bonarelli, Guido, & Nágera, J. J., Observaciones geologicas en las immediaciones del Lago San Martin (Territorio de Santa Cruz): Minist. Agricult. [Argentina], Direcc. Gen. de Minas, Geol. y. Hidrol., ser. B (Geología), bull. 27, p. 21, 1921.
GT: "*Gryphaea* (*Mimetostreon* n. subgen.) *corbiensis* (Moore)." TD: original.
FD: Moore, Charles, Australian Mesozoic geology and paleontology: Geol. Soc. London Quart. Jour., vol. 26, pp. 246–247, pl. 11, fig. 7, 1870. Described as *Avicula corbiensis* Moore, n. sp.
TL: Near Mount Corby, Australia.

The genus is hardly recognizable from Moore's description and must remain questionable until *Avicula corbiensis* Moore is reinvestigated. Bonarelli and Nágera believe it to be a subgenus of *Gryphaea* and are convinced that they can rectify the generic assignment of Moore's species. They claim also that the same species occurs in the Meseta shale, Albian, Lower Cretaceous, of Patagonia and figure Patagonian specimens.

s—MONOECIOSTREA Orton, J. H., The dominant species of Ostrea: Nature, vol. 121, pp. 320–321, 1928.
GT: "*Ostrea edulis* Linné." TD: subsequent by Iredale, Tom, Mollusca, pt. 1: Great Barrier Reef Expedition 1928–29, Sci. repts., vol. 5, no. 6, p. 394, British Mus. (Nat. History), 1939.

This subgeneric name was originally proposed as a substitute of "Ostrea, type subgenus" and must therefore have the same genotype species as *Ostrea* Linné, 1758. *Monoeciostrea* is an exact later synonym of *Ostrea* and superfluous.

v—NICAISOLOPHA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 20, 1936.
GT: "*N. Nicaisi* Coq." TD: original.
FD: Coquand, H., Géologie et paléontologie de la région Sud de la province de Constantine, p. 232, pl. 22, figs. 5–7, 1862. Described as *Ostrea Nicaisei* Coquand, n. sp.
SD: Coquand, H., Monographie du genre Ostrea, Terrain Crétacé, pp. 34–35, pl. 6, 1869.
TL: Campanian, Upper Cretaceous, of Mezâb-el-Messaï on the banks of the Oued-el-Kant'ra, Province of Constantine, Algeria.

v—NOTOSTREA Finlay, H. J., *in* Marwick, J., The Tertiary Mollusca of the Chatham Islands etc.: New Zealand Inst. Trans. Proc., vol. 58, p. 432, 1928.
GT: "*Ostrea subdentata* Hutton." TD: original.
FD: Hutton, F. W., Catalogue of the Tertiary Mollusca and Echinodermata of New Zealand, in the collection of the Colonial Museum: Colonial Mus. and Geol. Surv. Dept., pp. 34–35, 1873. [No illustration].
SD: Suter, Henry, Revision of the Tertiary Mollusca of New Zealand, based on type material, pt. 1: New Zealand Geol. Surv., Pal. Bull. 2, p. 46, pl. 17, figs. 9a, b, 1914.
Finlay, H. J., The recent mollusca of the Chatham Islands: New Zealand Inst. Trans. Proc., vol. 59, pp. 266–267, 1928.
TL: Trelissick group of Oamaru formation, Miocene, of Broken River, South Island, New Zealand. This locality is Miocene according to later authors.

v—NUTOGYRA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 20, 1936.
GT: "*Ex. Fourneli* Coq." TD: original.
FD: Coquand, H., Géologie et paléontologie de la région Sud de la province Constantine, pp. 229–230, pl. 21, figs. 1–3, 1862. Described as *Ostrea Fourneli* Coquand, n. sp.
SD: Coquand, H., Monographie du genre Ostrea, Terrain Crétacé, pp. 26–27, pl. 3, pl. 13, fig. 1, 1869.
TL: Maestrichtian, Upper Cretaceous, between Sidi-Abid and Taberdga and at Djélaïl, Province of Constantine, Algeria.
According to Pervinquière, Léon, Études de Paléontologie Tunisienne, II, Gastropodes et Lamellibranches des terrains crétacés: Carte géol. Tunisie, pp. 183–184, 1912, the *Ostrea Fourneli* Coquand is the same species as *Exogyra Overwegi* von Buch (Leopold von Buch *in* Beyrich, [E.], Bericht über die von Overweg auf der Reise von Tripoli nach Murzuk und von Murzuk nach Ghat gefundenen Versteinerungen: Deutsche geol. Gesell. Zeitschr., vol. 4, pp. 152–153, pl. 4, figs. 1–2, 1852). See also Rossi, C., Revisione e critica delle Exogyra overwegi von Buch (Maestrichtiano): Revista Italiana di Paleontologia, vol. 49, nos. 3–4, pp. 1–22, 1 pl., [Milano] 1943. [Not seen]; *teste* Thalmann.

v—ODONTOGRYPHAEA von Ihering, H., Les mollusques des terrains crétaciques supérieurs de l'Argentine orientale: An. Mus. Nac. Buenos Aires, ser. 3, vol. 2, pp. 193–227, 1903.
GT: "*Gryphaea rostrigera* Ih." TD: original (p. 212).
FD: von Ihering, H., Historia de las ostras argentinas: Anales Mus. Nac. Buenos Aires, vol. 7, (ser. 2, vol. 4), p. 113, 1902. Described but not figured as *Gryphaea concors* var. *rostrigera* von Ihering, n. sp. & n. var.
SD: von Ihering, H., *op. cit.*, pp. 211–212, pl. 2, figs. 10a–e, 1903. Described as *Gryphaea* (*Odontogryphaea*) *rostrigera* von Ihering.
Wilckens, O., Beiträge zur Palaeontologie von Patagonien: Neues Jahrb. für Min. etc., 1921, vol. 1, p. 3, pl. 2, figs. 4–5, 1922. [Figure only].
TL: Lower Roca beds, Sparnacian?, Upper Paleocene, west of Rio Chico, a tributary to Rio Chubut, near the coast of central Patagonia.

s—OSTRACARIUS Duméril, A. M. Constant, Zoologie analytique ou méthode naturelle de classification des animaux, p. 168, 1806.
GT: "*Ostrea edulis* Linné." TD: herewith designated.
This designation makes *Ostracarius* an exact synonym of *Ostrea* Linné, 1758. Duméril's molluscan generic names are discussed by Iredale, Tom, On two editions of Duméril's *Zoologie Analytique:* Malacol. Soc. London Proc., vol. 12, pp. 79–84, 1917. Iredale claims that *Ostracarius* is a new name for *Ostrea* Cuvier, Tableau élémentaire de l'Histoire naturelle des animaux, which in turn refers to the generic names of Linné. In that case *Ostracarius* is a substitute name for *Ostrea* Linné and must take the same type as the latter.

s—OSTRACITES Gmelin, J. F., Caroli a Linné systema naturae per regna tria naturae etc., ed. 13, vol. 3, p. 404. 1793. [Not seen].
GT: "*Ostrea edulis* Linné." TD: herewith designated.
Gmelin cites among the species listed by him on p. 405 the following "c. edulis. in Hungaria (prope Oedenburg, Budam, Marmoros) marmoreus." This citation evidently refers to *Ostrea edulis* Linné in the fossil state. Hence *O. edulis* is available for designation. Apparently there is no earlier type designation for *Ostracites*. This designation makes *Ostracites* an exact later synonym of *Ostrea*.

n—OSTRACOMORPHITES Desmarest, A. G., *in* Dictionnaire des sciences naturelles . . . , publié par les professeurs du Jardin du Roi et les principales écoles de Paris et rédigé par Cuvier, [ed. 2], vol. 37, p. 25, 1826.

Merely listed as an old, that is, pre-Linnean, term without giving it any validity in the following manner: "OSTRACOMORPHITES. (Foss.) Synonyme d'Ostracites. (DESM)."

e—OSTREA Sowerby, G. B., Jr., A conchological manual, [ed. 1], p. 75 and table opposite p. 6, London, 1839.

An emendation of *Ostrea* Linné, must be suppressed as a synonym according to Opinion 148.

v—OSTRAEA Linné, Carl, Systema naturae, etc., 10th ed., vol. 1, p. 696, 1758.
GT: "*Ostrea edulis* Linné." TD: subsequent by Schmidt, F. C., Versuch über die beste Einrichtung zur Aufstellung etc., p. 69, 1818. [Not seen].
FD: Linné, *op. cit.*
TL: Living on the coasts of Europe from Norway to Mediterranean.

The same genotype designation can be arrived at through absolute tautonymy as per Opinion 16, because Linné cited under the synonymy of *Ostrea edulis* the following: "*Bonan. recr.* 108. t. 70. Ostrea." This appears to be a pre-Linnean specific name eligible for absolute tautonymy according to Opinion 16, but the work referred to was not seen.

n—OSTREIGENUS Renier, S. A., Tavole per servire alla Classificazione e Connoscenze degli Animali, Padova, tabell 7, 1807. [Not seen].

Discussion given under *Gryphaeigenus* Renier applied here equally well.

v—OSTREINELLA Cossmann *in* Cossmann, M., & Peyrot, A., Conchologie néogenique de l'Aquitaine: Soc. Linn. Bordeaux Act., vol. 66, livr. 2, pp. 398–399, 1914.
GT: "*Liostrea* (*Ostreinella*) *neglecta* [Michelotti]." TD: original.
FD: Michelotti, Giovanni, Déscription des fossiles des terrains Miocènes de l'Italie septentrionale: Natuurkundige Verhandelingen van de Hollandsche Maatschappij der Wetenschappen te Haarlem, Tweede verzameling [ser. 2], vol. 3, p. 81, pl. 3, fig. 6 [not fig. 3], 1847.
SD: Cossmann & Peyrot, *op. cit.*, pp. 399–400, pl. 20, figs. 16–19.
TL: "Marmorito dans le Montferrat" [Michelotti 1847]. Miocene near Montferrat, Dépt. Var, southeastern France.

n—OSTREITES Herrmannsen, A. N., Indicis generum malacozoorum primordia, vol. 2, p. 177, 1847.

Merely listed as a pre-Linnean term as Ostreites Auctt. equal to Ostracites Auctt. without imparting to it any nomenclatural standing.

n—OSTREOCHAMITES Herrmannsen, A. N., Indicis generum malacozoorum primordia, vol. 2, p. 177, 1847.

Merely listed by Herrmannsen as "Ostreochamites Walch 1768. Verst. p. 134* t. [teste] Schröt. Lith. Lex. V. p. 90 / Genus Ostracitarum. / =Ostrea List. et Gryphaea Lamck." without imparting to it any nomenclatural standing. The name is presumably not binominal and not valid. No later valid use found.

v—OSTREOLA Monterosato, T., Nomenclatura generica e specifica di alcune conchiglie mediterranee, pp. 4–5, Palermo, 1884.
GT: "*O. Stentina*, Payr." TD: monotypic
FD: Payraudeau, B. C., Catalogue déscriptif et méthodique des Annélides et des Mollusques de l'isle de Corse, p. 81, pl. 3, fig. 3, 1826 [1827].
SD: Monterosato, *op. cit.*
TL: Living along coasts of Corsica. Also reported from western Mediterranean and Adriatic by Monterosato.

v—OSTREONELLA Romanovski, G., Matériaux pour la géologie du Turkestan, vol. 3, pp. 101–102, pl. 13-bis, figs. 3a–3e, 1890. [Russian edition.]
GT: "*Ostreonella prima*, n.f." TD: monotypic.
FD: Romanovski, G., *op. cit.*
TL: In micaceous, glauconitic, gray sandstone on the southwestern edge of the foothills of the Gissar range [Hissar Mountains] in Bukhara, about 30 versts east of Shir—Abad town, near Shakarbyk-Ostan, Uzbek Soviet Socialist Republic. Doubtfully referred to the Upper Cretaceous by Romanovski.

n—OSTREOPECTINITES Herrmannsen, A. N., Indicis generum malacozoorum primordia, vol. 2, p. 177, 1847.

Merely listed by Herrmannsen as "Ostreopectinites Walch 1768. Naturg. d. Verst. II. p. 134* teste Schröt. Lith. Lex. V. p. 91, 103. / Genus Ostracitarum. / =Ostrea List." without imparting to it any nomenclatural standing. No later valid use found. The name is presumably not binominal and not valid.

n—OSTREOPINNITES Herrmannsen, A. N., Indicis generum malacozoorum primordia, vol. 2, p. 177, 1847.

Merely listed by Herrmannsen as "Ostreopinnites Walch 1768. Verst. II* t. [teste] Schröt. Lith. Lex. V. p. 91. 104. / Division Ostracitarum. / =Ostrea List." without imparting to it any nomenclatural standing. No later valid use found. The name is presumably not binominal and not valid.

s—OSTREUM Da Costa, E. M., Historia naturalis testaceorum Britanniae, or, British Conchology; etc., pp. 154–164, 1778.
GT: "*Ostreum vulgare* Da C." TD: subsequent by Winckworth, W., Notes on Nomenclature: Proc. Malacol. Soc. London, vol. 17, pts. 2 and 3, p. 106, 1926.

The *Ostreum vulgare* Da Costa has in its synonymy on p. 154 *O. edulis* Linné, and it is obvious that the two names refer to the same species. If *Ostreum* is regarded as an emendation of *Ostrea* Linné, they must both have the same type species. If *Ostreum* is regarded as a new genus independent of *Ostrea* Linné, the above given type designation makes *Ostreum*

an exact synonym of *Ostrea* Linné, which has priority.

v—PALAEOSTREA Grabau, A. W., Early Permian fossils of China, pt. 2: Palaeontologia Sinica, ser. B, vol. 8, pt. 4, pp. 284–285, 1936. [Not seen].
GT: "*P. sinensis* Grabau, n. sp."
Probably not a true ostreid genus; *teste* N. D. Newell.

n—PELORIDERMA Poli, J. X., Testacea utriusque Siciliae etc., vol. 2, p. 255, 1795.
Poli's work is not binominal; therefore the name is not valid. Compare Dall, W. H., Further data on Poli's generic names: Malac. Soc. London Proc., vol. 8, pp. 251–252, 1909. Jukes-Brown, A. J., The application of Poli's generic names: Malac. Soc. London Proc., vol. 8, pp. 99–103, 1908.

e—PELORIDODERMA Agassiz, L. [Louis], Nomenclator zoologicus, etc., index universalis, p. 277, 1846.
An emendation of *Peloriderma* Poli and thus as invalid as the latter.

n—PELORIS Poli, J. X., Testacea utriusque Siciliae eorumque historia et anatome tabulis aeneis illustrata, vol. 1, pp. 33–34, 1791, and vol. 2, p. 255, 1795.
Poli's work is not binominal; therefore the name is not valid. See remarks under *Peloriderma*.

v—PERNOSTREA Munier-Chalmas, E., Description d'un nouveau genre monomyaire du terrain jurassique: Jour. Conchyl., ser. 3, vol. 4 (12), pp. 71–75, pl. 3, 1864.
GT: "*Pernostrea* (Perna) *Bachelieri*, d'Orbigny." TD: subsequent by Fischer, Paul, Note sur le genre Pernostrea: Jour. Conchyl., ser. 3, vol. 4 (12), pp. 362–368, 1864. [Designation on p. 364.]
FD: D'Orbigny, A., Prodrome de paléontologie stratigraphique universelle des animaux mollusques et rayonnés etc., vol. 1, p. 315, no. 341, 1850. Described as *Ostrea Luciensis* D'Orbigny, n. sp.
D'Orbigny, A., *op. cit.*, p. 341, no. 212, 1850. Described as *Perna Bachelieri* D'Orbigny, n. sp.
SD: Munier-Chalmas, E., *op. cit.* Described as *Pernostrea Bachelieri+Heberti+Ferryi+Fischeri+Pellati+Crossei*.
Fischer Paul, *op. cit.* Redescribed as *Pernostrea Bachelieri*, d'Orbigny from D'Orbigny's monotype, a right valve, and a topotype, a left valve.
Lycett, John, Supplementary monograph on the mollusca from the Stonesfield slate, etc.: Palaeontograph. Soc., vol. 15, p. 108, pl. 34, fig. 1a, 1862. Described as a monstrosity of *Ostrea Wiltonensis* Lycett, n. sp.
Boule, Marcellin, Types du Prodrome de Paléontologie stratigraphique universelle d'Alcide d'Orbigny: Annales de Paléontologie, vol. 8, p. 95 [p. 167 of separate], text fig., 1912. Redescribes *Ostrea luciensis* D'Orbigny from type material.
Mercier, Jean, A propos des Variations de l'aire ligamentaire d'*Ostrea wiltonensis* Lyc. et du genre *Pernostrea* Munier-Chalmas: Soc. Linn. Normandie bull., ser. 8, vol. 1, ann. 1928, trav. origin. pp. 3–7, 1929.
TL: Bathonian, Jurassic, of Luc, France, for *Ostrea luciensis* D'Orbigny. Callovian, Jurassic, of St. Scolasse-sur-Sarthe, France, for *Perna bachelieri* D'Orbigny. No localities given by Munier-Chalmas for his materials.
The following discussion is explanatory, compare Arkell, W. J., The oysters of the Fuller's Earth; and on the evolution and nomenclature of the Upper Jurassic Catinulas and Gryphaeas: Cotteswold Naturalists' Field Club, Proc. 1933, vol. 25, pt. 1, pp. 21–68, 1933 [1934]:
"One of the two right valves [of *Ostrea wiltonensis* Lycett] figured by Lycett was called by him a monstrosity, on account of its having an enormously elongated hinge-area with seven or eight ligament pits. On the strength of this and some more material, Munier-Chalmas, supported by Fischer, founded a new genus *Pernostrea*, supposed to be distinct from either *Perna* or *Ostrea*, but to form a link between the Ostreidae and Pernidae. Several subsequent authors, impressed by the authority of such eminent paleontologists, have respected the genus *Pernostrea*. Recently, however, . . . Jean Mercier has collected a large series of specimens from the Norman localities . . . and has investigated the ligament areas more closely. He finds that many specimens, otherwise indistinguishable from normal *Ostrea wiltonensis*, with which they are associated, have more than one ligament pit. Some have two, some three, and some four. In fact, 'starting with *O. wiltonensis*, there are oysters presenting variations in the number of their ligament pits so as to form a series ending with the shells figured by Munier-Chalmas and by Lycett.' M. Mercier therefore concludes that 'these variations . . . which, as Fischer remarked, are not important enough to consider as specific characters, are also insufficient *a fortiori*, as grounds for generic or even subgeneric separation'."
These oysters with multiple resilifers, which have received several specific names, are really a single variable unit as has been demonstrated by Jean Mercier. This being the case, the earliest-bestowed name, *O. luciensis* D'Orbigny, must apply to the unit.
Unfortunately the type species of *Pernostrea* and *Liostrea* are so closely related that it is necessary to use *Pernostrea*, 1864, for *Liostrea*, 1904, on account of priority.

v—PHRYGAEA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 19, 1936.
GT: "*Gr. Frauscheri* Vial. (=*Gr. Escheri* Frausch., non M.-E.)." TD: original.
FD: Gümbel, C. W. von, Geognostische Beschreibung des bayerischen Alpengebirges und seines Vorlandes / Herausgegeben auf Befehl des k. bayer. Staatsministeriums der

Finanzen / Gotha / Verlag von Justus Perthes / 1861, p. 659. [No illustration]. Described as *Ostrea pseudovesicularis* Guemb., n. sp.
SD: Frauscher, K. F., Das Unter-Eocän der Nordalpen und seine Fauna, pt. 1, Lamellibranchiata: Akad. Wiss. Wien, Math.-naturwiss. Kl., Denkschr., vol. 51, Abt. 2, pp. 53–54, pl. 2, figs. 2a–f, 3a–b, 4a–b, 1886. Described as *Ostrea Gryphaea Escheri* M.-E.
Traub, Franz, Geologische und Palaeontologische Bearbeitung der Kreide und des Tertiärs im östlichen Rupertiwinkel, nördlich von Salzburg: Palaeontographica, vol. 88, Abt. A, p. 49, pl. 2, figs. 13a–b, 1938. Redescribed as *Pycnodonta pseudovesicularis* Gümbel.
TL: Untere Nummulitengruppe, Parisian, of the Eisenerzflöze [iron ore beds] of the Kressenberg, southern Bavaria, according to Gümbel. Type locality of *Ostrea Escheri* Frauscher non Meyer-Eymar is the Lutetian, Middle Eocene, of Mattsee, Austria, according to Frauscher. Traub reported the species from the Wartstein near Mattsee, Austria, and corrected the stratigraphic age to Thanetian, upper Paleocene.

Vialov in renaming this species overlooked the earlier name *pseudovesicularis* which is apparently nomenclaturally correct for the genotype species.

v—PLANOSPIRITES Lamarck, J. B., Système des animaux sans vertèbres, etc., p. 400, 1801.
GT: "*Planospirites ostracina.*" TD: monotypic.
FD: Lamarck, *op. cit.*
SD: Jourdy E., Histoire naturelle des Exogyres: Ann. Pal., vol. 13, pp. 7–10, pl. 1, fig. 1, 1924. Figure of Lamarck's type specimen as *Planospirites ostreacina* Lamarck.
TL: Maestrichtian, Upper Cretaceous, of the St. Pierre Mountain near Maestricht, Netherlands.

This is an earlier name for the same group as *Exogyra*, and by rigid application of priority it should supersede *Exogyra*. However, *Planospirites* has been generally disregarded and should be suppressed by official action of the Commission.

v—PLATYGENA Romanowsky, H., Ferghana-Stufe der Kreideformation und ihr palaeontologischer Charakter: Russ. K. min. Gesell. St. Petersburg Verh., ser. 2, vol. 17, pp. 58–60, pls. 6–8, 1882. [In Russian].
GT: "*Platygena asiatica*, m." TD: monotypic.
FD: Romanowsky, G., Zwei neue Species der Austern-Familie vom Bezirk Fergansk: Russ. K. min. Gesell. St. Petersburg Verh., ser. 2, vol. 14, pp. 150–152, text fig. 1, 1879. Described as *Ostrea asiatica* Romanowsky, n. sp.
SD: Romanowsky, H., *op. cit.*, pp. 59–60, pls. 6–8, 1882.
Romanowsky, G., Matériaux pour la géologie du Turkestan, vol. 2, p. 77, 1884. [In Russian].
TL: Richetanian stage, Fergana group, basal Oligocene, of southeastern Turkestan.

v—PULVINOSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 17, 1936.
GT: "*O. fluctuosa* M.-E." TD: original.
FD: Mayer-Eymar, [Charles], Diagnoses d'huîtres nouvelles des terrains nummulitiques d'Égypte: Bull. Soc. Belge Géol., mém., vol. 3, p. 403, 1889. [No illustrations].
SD: Oppenheim, Paul, Zur Kenntniss alttertiärer Faunen in Ägypten: Palaeontographica, vol. 30, pt. 3, pp. 32–33, pl. 1, figs. 12, 12a, 12b, 1903.
TL: Lower Londinian, Eocene, of Nobka, Oasis of Farafrah, Egypt [Meyer-Eymar]; Libyan [Oppenheim].

e—PYCNODONTA Sowerby, G. W., Jr., A conchological manual, ed. 2, p. 85, 1842.

An unnecessary emendation of *Pycnodonte;* as such it must have the same type species as the latter. Rejected as a synonym of *Pycnodonte* according to Opinion 148.

v—PYCNODONTE Fischer, G. [de Waldheim], Lettre à M. le Baron Férussac sur quelques genres de coquilles du Muséum Demidoff et en particulier sur quelques coquilles fossiles de la Crimée: Bull. Soc. Imp. des Naturalistes de Moscou, vol. 8, pp. 117–119, 1835.
GT: "*Pycnodonte radiata.*" TD: original (p. 119).
FD: Fischer de Waldheim, *op. cit.*, described as *P. radiata* Fischer, n. sp.
TL: Upper Cretaceous of the narrows between the rivers Alma and Bodrok in the Crimea, U.S.S.R.

e—PYCNODONTES Herrmannsen, A. N., Indicis generum malacozoorum primordia, vol. 2, p. 373, 1847.

Emendation or misprint of *Pycnodonte;* rejected according to Opinion 148.

e—PYCNODUNTA Sowerby, G. W., Jr., A conchological manual, ed. 4, p. 259, 1852.
Emendation or misprint of *Pycnodonte.*

v—QUADROSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vo. 4 (13), no. 1 (105), p. 18, 1936.
GT: "*O. tetragona* Bayle." TD: original.
FD: Bayle, E., *in* Fournel, Henri, Richesse minerale de l'Algérie etc., vol. 1, p. 367, pl. 17, figs. 24, 25, 1849. [Atlas not seen].
SD: Coquand, H., Géologie et paléontologie de la région Sud de la province de Constantine, p. 229, pl. 20, figs. 11–12, 1862.
Coquand, H., Monographie du genre Ostrea, terrain Crétacé, p. 54, pl. 24, figs. 2–6, 1869.
Pervinquière, Léon, Études de Paléontologie Tunisienne, II, Gastropodes et Lamellibranches des terrains crétacés: Carte géol. Tunisie, pp. 170–172, 1912.
TL: Lower Campanian, Upper Cretaceous, of Mezâb-el-Messaï, between Constantine and Biskra, province of Constantine, Algeria, according to Bayle and Coquand, 1862. Santonian, Upper Cretaceous, according to Pervinquière.

v—RASTELLUM (Schröter, J. S., Lithologisches Real- und Verballexikon, etc., vol. 5, pp. 74, 382, 390, 1782. [Not seen],

Reused by Rollier, Louis, Les faciès du Dogger ou oolithique dans le Jura et les régions voisines: Mém. publié par la fondation Schnyder von Wartensee à Zurich, pp. 268, 274–278, 1911.
GT: Questionable. "*Mytilus cristagalli* Chemnitz (Recent sp.)" was designated the genotype species by Arkell, W. J., A monograph of British Corallian Lamellibranchia, pt. 4: Palaeontograph. Soc., vol. 84, p. 180, 1932. However, this species was clearly excluded from *Rastellum* by Rollier on p. 268. In view of the discussion given below it seems unnecessary to clarify the question of a genotype.

Rastellum was used by pre-Linnean authors and taken over from them by Schröter. However, Schröter was not a binominal author according to Sherborn, C. D., Index Animalium, 1758–1800, pl. xlix, 1902. Therefore his genus *Rastellum* is not acceptable under Article 25b of the Rules of Zoological Nomenclature. *Rastellum* was used by Mörch, O. A. L., Catalogus conchyliorum quae reliquit C. P. Kierulf, MD. DR. Nunc publica auctione X decembris MDCCCL Hafniae dividenda, p. 26, 1850. This is a sales catalog as indicated by its title; hence it has no scientific standing and must be disregarded for nomenclatural purposes (compare Opinion 51). *Rastellum*, to be valid, must date from Rollier, 1911. The latter author did not establish *Rastellum* as a new or newly proposed genus but stated clearly on page 268 that he regarded it as "*Rastellum* Schröter (1782)."

If *Rastellum* Mörch, 1850, were valid it would take "*Ostrea* (*Rastellum*) *plicata* Ch." = *Ostrea plicatula* Gmelin as the genotype by monotypy, because out of five species listed by Mörch it is the only one that is available, the others being either affixed with a question mark or merely listed as "sp." *Alectryonella* has the same genotype species.

v—RHYNCHOSTREON (Bayle, E., Fossiles principaux des terrains: Explication de la carte géol. de la France, etc., vol. 4, atlas, pt. 1, pl. 138, figs. 1–5, 1878.)
Douvillé, [H.], Présentation de l'Atlas . . . par M. Bayle, etc.: Soc. géol. France, bull., ser. 3, vol. 7, pp. 91–92, 1879.
GT: "*R. Chaperi*, Bayle, = *O. columba*, auct." TD: by Douvillé, *op. cit.*
FD: Lamarck, J. B. P. A. de, Histoire naturelle des animaux sans vertèbres, etc., [ed. 1], vol. 6, p. 198, 1819. Described as *Gryphaea. columba* Lamarck, n. sp.

The species *Gryphaea plicatula* Lamarck and *G. silicea* Lamarck, n. spp., described in the same work on pp. 199 and 200 respectively, are regarded as identical with *G. columba* Lamarck.
SD: Bayle, E., *op. cit.* Figured as *Rhynchostreon Chaperi*. Bayle.
Pervinquière, Léon, Études de paléontologie Tunisienne, pt. 2, Gastropodes et Lamellibranches des Terrains Crétacés: Carte géol. Tunisie, p. 181, 1912.
Pervinquière, L., *in* Palaeontologia universalis, ser. 3, fasc. 2, fiche 190, 190a, 190b, 1910. Redescribed as *Exogyra* (*Rhynchostreon*) *columba* (Lamarck).
TL: Cenomanian, Upper Cretaceous, of the vicinity of le Mans, France.

This species has received several trivial names, which are reviewed by Pervinquière, *op. cit.* The earliest valid species name is *Gryphaea suborbiculata* Lamarck, n. sp., in Lamarck, J. B., Système des animaux sans vertèbres, etc., p. 398, 1801. Strict application of the Rules makes *suborbiculata* the correct trivial name.

The correct quotation of the genus is *Rhynchostreon* Bayle in Douvillé, 1879, compare discussion under *Actinostreon*.

v—SAXOSTREA Iredale, Tom, Australian molluscan notes, no. 2: Australian Mus. Rec., vol. 19, no. 5, p. 269, 1936.
GT: "*Ostrea commercialis* Iredale & Roughley." TD: monotypic.
FD: Iredale, Tom, & Roughley, T. C., The scientific name of the commercial oyster of New South Wales: Linn. Soc. New South Wales Proc., vol. 58, p. 278, 1933.
Roughley, T. C., The life history of the Australian oyster (Ostrea commercialis): Linn. Soc. New South Wales Proc., vol. 58, pp. 279–333, 1933.
TL: Living along coasts of eastern Australia, from far north Queensland to as far south as Wingan Inlet in Victoria.

e—SINOSTREA Haas, F. [=Fritz], Bivalvia Teil II, 2. Lieferung: Dr. H. G. Bronns Klassen und Ordnungen des Tierreichs, Dritter Band Mollusca, 3. Abteilung, p. 294, 1938.

Haas assumed that Vialov's *Sinustrea* was a misprint; hence he emended it. There is no definite indication of a misprint in Vialov, and the emendation is unnecessary.

v—SINUSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 18, 1936.
GT: "*O. Morgani* Vredenb." TD: original.
FD: Vredenburg, E. W., Flemingostrea, an eastern group of Upper Cretaceous and Eocene Ostreidae: etc.: Geol. Surv. India Rec., vol. 47, pt. 3, pp. 197–199, pl. 17, 18, 1916. Described as *Ostrea* (*Flemingostrea*) *morgani* Vredenburg, n. sp.
TL: From the *Indoceras baluchistanense* and *Sphenodiscus ubaghsi* zone of the upper Maestrichtian, Upper Cretaceous, of the Mari Hills, Baluchistan.

v—SOKOLOWIA Böhm, J., Die palaeogene Fauna Ost-Turkestans: Deutsche geol. Gesell. Zeitschr., vol. 85, no. 2, pp. 104–105, 1933.
GT: "*Sok. esterhazyi* (Pav.) var." TD: original.
FD: Pavay, E. or A. von, Kolozsvár Környékének földtani viszonyai: Magyar Földtani Intézet. Évk., vol. 1, pp. 375, 382, pls. 6–9, 1871. [Not seen].
SD: Böhm, *op. cit.*, pp. 105–107, pl. 10, fig. 1, 1933.

v—STRIOSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 17, 1936.
GT: "*O. procellosa* Valenc. [=*O. multistriata* Hanley 1845 (non Desh.)]." TD: original.
FD: Hanley, Sylvanus, Descriptions of new species of *Ostrea*, in the collection of Hugh Cuming, Esq.: Zool. Soc. London, Proc. for 1845, pt. 13, p. 106, 1846. Described as *Ostrea multistriata* Hanley, n. sp.
SD: Valenciennes [Not seen].
TL: "The lower valves were attached by their entire surfaces to a ship returning from the coast of Africa" [Hanley].

v—TURKOSTREA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 18, 1936.
GT: "*O. turkestanensis* Rom." TD: original.
FD: Romanowski, G., Matériaux pour la géologie du Turkestan, vol. 1, p. 112, pl. 10, figs. 2a–c; pl. 11, figs. 3a, b; pl. 12, figs. 2, 2a; 1878. [In Russian]. [Not seen].
Romanowski, G., Materialen zur Geologie von Turkestan, Lief. 1, pp. 95–96, pl. 10, figs. 2a–c; pl. 11, figs. 3a, b; pl. 12, figs. 2, 2a; 1880. [In German].
SD: Cox, L. R., Fossiles Éocènes du nord de l'Afghanistan: Soc. géol. France Mém. 39, n. s., vol. 17, fasc. 1, pp. 32–35, 1938.
Cox regards *O. turkestanensis* Romanowski to be the same as *Ostrea multicostata* Deshayes var. *strictiplicata* V. Raulin & J. Delbos.
TL: Alaï stage, probably Lutetian, Middle Eocene, south of Ura-Tube, also in the district Chodshend and in southern part of district Kuraminsk in Russian Turkestan.

n—VIRGULA Arkell, W. J., The oysters of the Fuller's Earth: etc.: Cotteswold Naturalists' Field Club, Proc. 1933, vol. 25, pt. 1, p. 64, 1933 [1934].
Proposed as a "stage name" and on purpose written in lower case letters. Not valid on account of failure to designate a type species.

v—VULTOGRYPHAEA Vialov, O. S., Sur la classification des huîtres: Acad. Sci. U.R.S.S., comptes rendus (doklady), n. s., vol. 4 (13), no. 1 (105), p. 19, 1936.
GT: "*Gr. vultur* Coq." TD: original.
FD: Coquand, H., Monographie du genre Ostrea, Terrain Crétacé, p. 118, pl. 39, figs. 1–4, 1869.
SD: Bayle, E., Fossiles principaux des terrains: Explication de la carte géol. de la France, etc., vol. 4, atlas, pt. 1, pl. 141, figs. 1, 2, 1878. Figured as *Rhynchostreon vultur*. Coquand, sp.
TL: Cenomanian, Upper Cretaceous, of Boneuil-Matours, Dépt. Vienne, France.

AUTHOR INDEX

ALPHABETICALLY ARRANGED

Agassiz 1846, *Dendrostrea, Peloridoderma.*
Arkell 1934, *Acuminata, Bilobata, Cretagryphaea, Dilatata, Incurva, Jurogryphaea, Knorrii, Marcoui, Virgula.*
Bayle 1878, *Actinostreon, Aetostreon, Ceratostreon, Rhynchostreon.*
Bittner 1901, *Enantiostreon.*
Blainville 1821, *Griphaea.*
Böhm 1933, *Sokolowia.*
Bolten 1798, *Lopha.*
Bonarelli & Nágera 1921, *Mimetostreon.*
Bosc 1802, *Gryphoea.*
Conrad 1865, *Gryphaeostrea, Gryphoeostrea.*
Cossmann 1914, *Ostreinella.*
1922, *Biauris.*
Da Costa 1778, *Ostreum.*
Dall 1898, *Lopha.*
Defrance 1826, *Ostreocamites.*
Desmarest 1826, *Ostracomorphites.*
Douvillé 1879, *Actinostreon, Aetostreon, Ceratostreon, Rhynchostreon.*
1904, *Liostrea.*
Duméril 1806, *Ostracarius.*
Finlay 1928, *Notostrea.*
Fischer 1886, *Liogryphaea.*
Fischer de Waldheim 1807, *Alectryonia.*
1829, *Amphidonte.*
1835, *Pycnodonte.*
Gmelin 1793, *Ostracites.*
Grabau 1936, *Palaeostrea.*
Haas 1938, *Biaurus, Ceratostrea, Circographaea, Goridzella, Gryphostrea, Sinostrea.*
Herrmannsen 1847, *Limnostracites, Ostreites, Ostreochamites, Ostreopectinites, Ostreopinnites, Pycnodontes.*
Ihering 1903, *Odontogryphaea.*
1907, *Eostrea.*
Iredale 1936, *Saxostrea.*
Jaworski 1913, *Euostrea, Heterostrea.*
Lamarck 1801, *Gryphaea, Planospirites.*
Linné 1758, *Ostrea.*
Lissajou 1923, *Catinulus.*
Marwick 1931, *Crenostrea.*
Monterosato 1884, *Ostreola.*
Mörch 1850, *Rastellum*
Munier-Chalmas 1864, *Pernostrea*
Orton 1928, *Dioeciostrea, Monoeciostrea.*
Pervinquière 1910, *Arctostrea.*
Poli 1791, *Peloris.*
1795, *Peloriderma.*
Renier 1807, *Gryphaeigenus, Ostreigenus.*
Risso 1826, *Gryphea.*
Rollier 1911, *Catinula, Rastellum.*
1917, *Deltoideum.*
Romanowski 1882, *Platygena.*
1890, *Ostreonella.*
Sacco 1897, *Alectryonella, Crassostrea, Cubitostrea, Cymbulostrea, Gigantostrea.*
Say 1820, *Exogyra.*
Schlottheim 1813, *Gryphites.*

Schröter 1782, *Rastellum*.
Scudder 1882, *Amphidonta*.
Sowerby 1839, *Dendostraea*, *Ostraea*.
1842, *Pycnodonta*.
1852, *Pycnodunta*.
Suter 1917, *Anodontostrea*.
Swainson 1835, *Dendostrea*.
1840, *Dendrostraea*.
Vialov 1936, *Abruptolopha*, *Acutostrea*, *Agerostrea*, *Angustostrea*, *Anulostrea*, *Avia*, *Bellostrea*, *Cameleolopha*, *Circogryphaea*, *Costagyra*, *Curvostrea*, *Fatina*, *Ferganea*, *Fluctogyra*, *Gorizdrella*, *Kokanostrea*, *Labrostrea*, *Margostrea*, *Nicaisolopha*, *Nutogyra*, *Phrygaea*, *Pulvinostrea*, *Quadrostrea*, *Sinustrea*, *Striostrea*, *Turkostrea*, *Vultogryphaea*.
Vredenburg 1916, *Flemingostrea*.

CHRONOLOGICAL INDEX

1758, *Ostrea* Linné.
1778, *Ostreum* Da Costa.
1782, *Rastellum* Schröter.
1791, *Peloris* Poli.
1793, *Ostracites* Gmelin.
1795, *Peloriderma* Poli.
1798, *Lopha* Bolten.
1801, *Gryphaea* Lamarck, *Planospirites* Lamarck.
1802, *Gryphoea* Bosc.
1806, *Ostracarius* Duméril.
1807, *Alectryonia* Fischer de Waldheim, *Gryphaeigenus* Renier, *Ostreigenus* Renier.
1813, *Gryphites* Schlottheim.
1820, *Exogyra* Say.
1821, *Griphaea* Blainville.
1826, *Gryphea* Risso, *Ostreocamites* Defrance, *Ostracomorphites* Desmarest.
1829, *Amphidonte* Fischer de Waldheim.
1835, *Pycnodonte* Fischer de Waldheim, *Dendostrea* Swainson.
1839, *Dendostraea* Sowerby, *Ostraea* Sowerby.
1840, *Dendrostraea* Swainson.
1842, *Pycnodonta* Sowerby.
1846, *Dendrostrea* Agassiz, *Peloridoderma* Agassiz.
1847, *Limnostraciles* Herrmannsen, *Ostreites* Herrmannsen, *Ostreochamites* Herrmannsen, *Ostreopectinites* Herrmannsen, *Ostreopinnites* Herrmannsen, *Pycnodontes* Herrmannsen.
1850, *Rastellum* Mörch.
1852, *Pycnodunta* Sowerby.
1864, *Pernostrea* Munier-Chalmas.
1865, *Gryphaeostrea* Conrad, *Gryphoeostrea* Conrad.
1878, *Actinostreon* Bayle, *Aetostreon* Bayle, *Ceratostreon* Bayle, *Rhynchostreon* Bayle.
1879, *Actinostreon* Douvillé, *Aetostreon* Douvillé, *Ceratostreon* Douvillé, *Rhynchostreon* Douvillé.
1882, *Amphidonta* Scudder.
1882, *Platygena* Romanowski.
1884, *Ostreola* Monterosato.
1886, *Liogryphaea* Fischer.
1890, *Ostreonella* Romanowski.
1897, *Alectryonella* Sacco, *Crassostrea* Sacco, *Cubitostrea* Sacco, *Cymbulostrea* Sacco, *Gigantostrea* Sacco.
1898, *Lopha* Dall.
1901, *Enantiostreon* Bittner.
1903, *Odontogryphaea* Ihering.
1904, *Liostrea* Douvillé.
1907, *Eostrea* Ihering.
1910, *Arctostrea* Pervinquière.
1911, *Catinula* Rollier, *Rastellum* Rollier.
1913, *Euostrea* Jaworski, *Heterostrea* Jaworski.
1914, Ostreinella Cossmann
1916, *Flemingostrea* Vredenburg.
1917, *Anodontostrea* Suter, *Deltoideum* Rollier.
1921, *Mimetostreon* Bonarelli & Nágera.
1922, *Biauris* Cossmann.
1923, *Catinulus* Lissajou,
1928, *Dioeciostrea* Orton, *Monoeciostrea* Orton, *Notostrea* Finlay.
1931, *Crenostrea* Marwick.
1933, *Sokolowia* Böhm.
1934, *Acuminata* Arkell, *Bilobata* Arkell, *Cretagryphaea* Arkell, *Dilatata* Arkell, *Incurva* Arkell, *Jurogryphaea* Arkell, *Knorrii* Arkell, *Marcoui* Arkell, *Virgula* Arkell.
1936, *Palaeostrea* Grabau, *Saxostrea* Iredale, *Abruptolopha* Vialov, *Acutostrea* Vialov, *Agerostrea* Vialov, *Angustostrea* Vialov, *Anulostrea* Vialov, *Avia* Vialov, *Bellostrea* Vialov, *Cameleolopha* Vialov, *Circogryphaea* Vialov, *Costagyra* Vialov, *Curvostrea* Vialov, *Fatina* Vialov, *Ferganea* Vialov, *Fluctogyra* Vialov, *Gorizdrella* Vialov, *Kokanostrea* Vialov, *Labrostrea* Vialov, *Margostrea* Vialov, *Nicaisolopha* Vialov, *Nutogyra* Vialov, *Phrygaea* Vialov, *Pulvinostrea* Vialov, *Quadrostrea* Vialov, *Sinustrea* Vialov, *Striostrea* Vialov, *Turkostrea* Vialov, *Vultogryphaea* Vialov.
1938, *Biaurus* Haas, *Ceratostrea* Haas, *Circographaea* Haas, *Goridzella* Haas, *Gryphostrea* Haas, *Sinostrea* Haas.

SYNONYMS AND EMENDATIONS OF SIX GROUPS

Rastellum Mörch, 1850 = ALECTRYONELLA SACCO 1897.
Rastellum Schröter, 1782 = *Lopha* Bolten, 1798 = ALECTRYONIA Fischer de Waldheim, 1807 = *Lopha* Dall, 1898 = *Rastellum* Rollier, 1911.
CRASSOSTREA Sacco, 1897 = *Euostrea* Jaworski,

1913 = *Dioeciostrea* Orton, 1928 = *Gryphaea* of later authors, not Lamarck, 1801.

GRYPHAEA Lamarck, 1801 = *Gryphoea* Bosc, 1802 = *Gryphaeigenus* Renier, 1807 = *Gryphites* Schlottheim, 1813 = *Griphaea* Blainville, 1821 = *Gryphea* Risso, 1826 = *Liogryphaea* Fischer, 1886 = *Jurogryphaea* Arkell, 1934.

OSTREA Linné, 1758 = *Ostreum* Da Costa, 1778 = *Ostraciles* Gmelin, 1793 = *Ostracarius* Duméril, 1806 = *Ostreigenus* Renier, 1807 = *Ostracomorphites* Defrance, 1826 = *Ostraea* Sowerby, 1839 = *Ostreites* Herrmannsen, 1847 = *Ostreochamiles* Herrmannsen, 1847 = *Ostreopectinites* Herrmannsen, 1847 = *Ostreopinnites* Herrmannsen, 1847 = *Monoeciostrea* Orton, 1928.

PYCNODONTE Fischer de Waldheim, 1835 = *Pycnodonta* Sowerby, 1842 = *Pycnodontes* Herrmannsen, 1847 = *Pycnodunta* Sowerby, 1852 = *Cretagryphaea* Arkell, 1934.

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JOURNAL OF PALEONTOLOGY, VOL. 21, NO. 2, P. 186, MARCH 1947

PALEONTOLOGICAL NOTES

NEW NAMES FOR TWO SPECIES OF FORAMINIFERA FROM THE LOWER TERTIARY OF THE NETHERLANDS

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Dr. Joseph Cushman has recently called my attention to the fact that two of my specific names in Die Stratigraphische Gliederung des Niederländischen Eozäns und Palaozäns nach Foraminiferen are preoccupied. *Rotalia granulosa* ten Dam 1945, is preoccupied by *Rotalia granulosa* Karrer 1868. I propose the new name *R. bartoniana* to replace it. *Glandulina nitida* ten Dam 1945 is preoccupied by *Glandulina nitida* Neugeboren 1850. I propose the new name *G. peelensis* to replace it.

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NEUGEBOREN, J. L., 1850, Foraminiferen von Felsö-Lapugy unweit Bobra im Carlsburger Distrikt, ehemals Hunyader Comitat, Artikel I, *Glandulina*, Verh. Mitth. Sienbenb. Ver. Nat., pp. 45–48, 50–53, pl. 1.

NEW NAMES FOR TWO SPECIES OF FORAMINIFERA FROM THE MIDDLE MIOCENE OF THE NETHERLANDS

A. TEN DAM AND TH. REINHOLD
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Mr. Hans E. Thalmann has recently called our attention to the fact that two of our specific names in Die Stratigraphische Gliederung des Niederländischen Oligo-Miozäns nach Foraminiferen, are preoccupied. *Cristellaria* (*Robulus*) *grandis* ten Dam and Reinhold, 1942 is preoccupied by *C. americana grandis* Cushman 1920, from the Lower Miocene of Florida. We propose the new name *Cristellaria* (*Robulus*) *teschi*, in honor of Dr. Ir. P. Tesch, former Director of the Netherlands State Geological Survey, to replace it.

Vaginulina striatula ten Dam and Reinhold 1942, is preoccupied by *V. striatula* Roemer 1842, from the Cretaceous of Germany. We propose the new name *V. obtusicosta* ten Dam and Reinhold to replace it.

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CUSHMAN, J. A., 1920, Lower Miocene of Florida. U. S. Geol. Survey, Prof. Paper 128-B.
ROEMER, J. A., 1842, Neue Kreide-Foraminiferen, Neues Jahrb. fur Min., Geol., Pal.

THE CATALOGUE OF FORAMINIFERA

The Department of Micropaleontology of the American Museum of Natural History is attempting to recall sets of the Catalogue of Foraminifera issued to individual subscribers who have permitted their membership to lapse. This is being done in order that other individuals wishing to establish and maintain membership can be supplied with copies of the Catalogue. New copies are not available to individuals as all of the remaining sets are reserved for institutions and companies.

Inactive members who wish to dispose of

their sets of the Catalogue are requested to communicate with the Department of Micropaleontology of the American Museum. Full refund of dues will be made for sets in good condition and all transportation costs will be paid by the Department.

MONARCHOPEMMATITES, A NEW GENUS NAME FOR A FOSSIL SPONGE

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In a report on new Carboniferous and Permian sponges, State Geological Survey of Kansas, Bulletin 47, 1943, p. 16, pl. 3, figs. 10, 12, Mr. R. H. King proposed the name *Pseudopemmatites* for a new genus, with *P. skinneri*, new species, as genotype. *Pseudopemmatites* was used for another genus of fossil sponge by Fraipont in 1911 (Ann. Soc. géol. Belgique, 38, Mem. No. 14, p. 197). Therefore, I propose that it be designated *Monarchopemmatites*. The syllables "monarch" are a translation into Greek of the name King, thus avoiding a word compounded from different language roots. Nonetheless this name is proposed in honor of Mr. King, a prominent contemporary paleontologist.

The type of the genus described by King remains as University of Kansas specimen No. 74167, Kansas Geol. Survey Bull. 47, pl. 3, fig. 12, which is *Monarchopemmatites skinneri* (King) de Laubenfels.

JOURNAL OF PALEONTOLOGY, VOL. 21, NO. 2, PP. 187–188, MARCH 1947

REVIEWS

FORAMINIFERA FROM THE MIDDLE EOCENE IN THE SOUTHERN PART OF THE NETHERLANDS PROVINCE OF LIMBURG, R. C. van Bellen—Mededeelingen Geologische Stichting, Series C.V. No. 4, p. 1–144, pl. 1–13, 11 textfigs., 1 table—Ernest van Aelst, Maestricht, 1946.

In this important contribution to the knowledge of the Foraminifera of the Tertiary in the Netherlands the author deals with the interesting microfauna of the Bunde limestone of Limburg hitherto considered to be partly Upper Senonian and partly Danian or Paleocene in age. Van Bellen attempts to prove the Middle Eocene age of these beds based on their microfossil content. Unfortunately war conditions prevented him from examining samples from lower Tertiary limestones of the Mons and Paris basins, especially of the "calcaire pisolithique" (Montian), which would have prevented his premature conclusions on the age of his fauna. Early in March 1946 I had the opportunity to collect some samples in the "calcaire pisolithique" of Montian (Paleocene) age near Paris. Washings of these samples showed a microfauna with exactly the same species as the Bunde fauna. Moreover, in November 1945 I sent some samples from the Bunde-limestone to Pierre Marie, micropaleontologist of the Bureau des Recherches Géologiques et Géophysiques in Paris and he wrote me: "Les échantillons du calcaire de Bunde sont du Montien des plus typiques, toutes les espèces qui se rencontrent dans les préparations se retrouvent dans le bassin de Paris, ainsi qu' à Mons (Belgique)." From these facts it is clear that the Bunde fauna of van Bellen is typically of Montian (Paleocene) age and not Middle Eocene. The author was impressed by the presence of many species which lived in Eocene and Oligocene times, and the relatively small number of Paleocene Foraminifera. Because of the very limited literature on Paleocene Foraminifera of Europe and America and the very extensive literature on Eocene and Oligocene microfaunas it is no wonder that he found more species in common with the well known Eocene and Oligocene and only few in common with the Paleocene. A single, broken, badly preserved fragment of two chambers only, which was identified as *Hantkenina alabamensis* Cushman, seems to be doubtful evidence of Eocene age.

As a first description of the Montian microfauna of this part of Europe this work is very important. The author described 112 species, 37 of them identified from single specimens only. Most material is badly preserved, although it is generally better than that from the Paris basin. Described as new are 2 genera, 22 species and 3 varieties and 1 new name is introduced. In the text, the exact number of specimens of each species is indicated. The plates are well designed.

A TEN DAM

THE FORAMINIFERA FROM THE HERVIAN (CAMPANIAN) OF SOUTHERN LIMBURG by Ernest Schijfsma—Mededeelingen Geologische Stichting—Series C.V. No. 7, pp. 1–174, pl. 1–10, 5 textfigs., 4 tables—Ernest van Aelst, Maestricht—1946.

This excellent contribution to the knowledge of the Foraminifera of the Upper Cretaceous of the Netherlands and Western Europe in general describes the interesting microfauna from the sandy glauconitic facies of the Hervian (Campanian) of Southern Limburg, hitherto considered to be Upper Lower Senonian but, according to the author, most probably Lower Upper Senonian.

The microfauna consists of 91 species and varieties of Foraminifera belonging to 49 genera and 20 families. A total of 15 new species and 3 new varieties are described. All of the descriptions are based on several to many specimens so that individual variability could thoroughly be taken into account.

About 30% of this microfauna consists of agglutinate forms, and even some calcareous forms seem to assimilate small sandgrains in the formation of the last chambers. In addition to small Foraminifera, the author found a dwarf-fauna of *Orbitoidae* and *Calcarinidae*, generally the same species which occur abundantly in the Maestrich-

tien. Descriptions and figures are very clear. For many species a complete synonymy is given and the differential diagnosis of most species is rather extensive. Species-conception, nomenclature and work-system are about the same as those of Brotzen, Marie and ten Dam, which makes comparison and correlation with Sweden and France easy and reliable. For future work in Western Europe and even elsewhere this coordination of work-system may be very important.

In his conclusions the author compares this fauna with others from the Upper-Cretaceous of Western-Europe, especially a rich Campanian Fauna from the Paris-basin described by Marie. The Hervian fauna shows a much greater affinity to the Maestrichtien than to the Santonian, for which reason the author placed the Hervian in the middle Campanian and the Campanian at the base of the Upper Senonian. The stratigraphical part will certainly be of much value for future workers on the Upper Cretaceous of Western Europe. With Marie's monograph on the foraminifera from the limestone facies of the Campanian in the Paris-basin this work on the Foraminifera from sandy glauconitic facies of similar age forms an important survey of the Campanian microfaunas of Western Europe in general.

A. TEN DAM

ERRATA

Delay from unforeseen circumstances resulted in No. 6 of Vol. 20 of this JOURNAL being mailed on Dec. 8, 1946, instead of Nov. 20 as stated on the reverse of the Volume title page.

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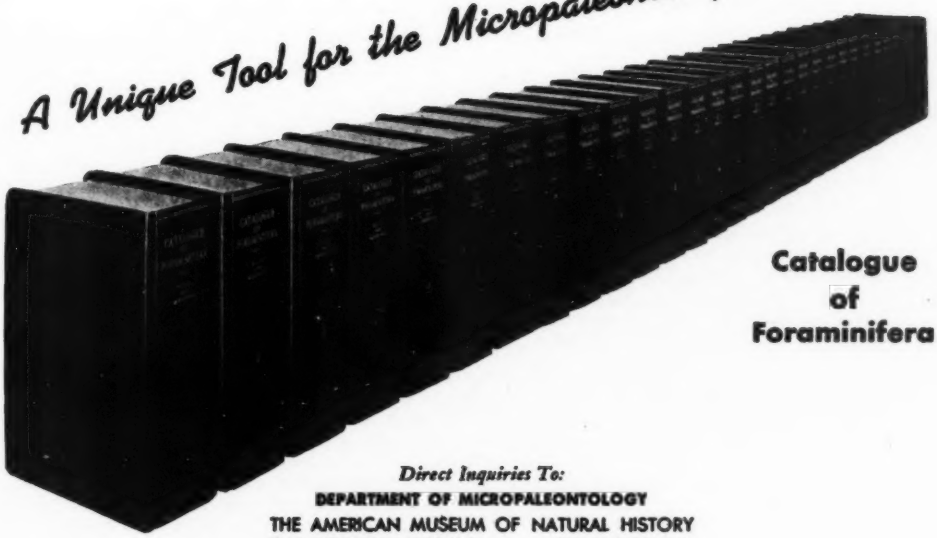

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